ENTREPRENEURSHIP IN THE KNOWLEDGE BASED ECONOMY: A SPATIAL ANALYSIS OF GREAT BRITAIN 2008-2010

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ENTREPRENEURSHIP IN THE KNOWLEDGE BASED ECONOMY: A SPATIAL ANALYSIS OF GREAT BRITAIN 2008-2010

BY

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Abstract

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ENTREPRENEURSHIP IN THE KNOWLEDGE BASED ECONOMY: A SPATIAL ANALYSIS OF GREAT BRITAIN 2008-2010

Entrepreneurship is increasingly recognised as an important component of the contemporary knowledge based economy and crucial to the attainment of economic growth and development. However, entrepreneurial activity varies significantly across space within countries. This thesis makes an original contribution by examining the determinants of spatial variations in entrepreneurship across sub-regions of Great Britain from 2008-2010. Through utilising newly available data on firm births and applying exploratory spatial data analysis and spatial econometric techniques, two prominent theories of entrepreneurship are examined. First, the Knowledge Spillover Theory of Entrepreneurship posits that underutilised knowledge by incumbent firms creates entrepreneurial opportunities. The appropriation of these opportunities through entrepreneurial activity, in the form of a new firm, leads to dynamic knowledge spillovers, which generate economic growth. The empirical analysis presented in this thesis concludes that more knowledge intensive regions exhibit significantly higher firm birth rates; however the composition of the regional knowledge stock is critical, as a diverse knowledge stock generates more entrepreneurial opportunities. Second, several theories emphasise the importance of idiosyncratic knowledge and human capital, in the form of entrepreneurial ability, on the discovery and exploitation of entrepreneurial opportunities. The results of this thesis suggest that human capital is vital to the entrepreneurial process, and that university education is a greater source of entrepreneurial ability than labour market experience. Furthermore, the results also suggest that the regulatory burden of the public sector, financial constraints, regional unemployment, and the absence of a local entrepreneurial culture can significantly detract from regional entrepreneurial activity. In light of these results, there are several implications for policy which include: emphasising the importance of effective policy towards intellectual property rights, targeting entrepreneurial education initiatives towards university students and graduates, and reducing unnecessary public sector regulation that can act as a 'barrier' to entrepreneurship.

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List of Abbreviations

2SLS – Two Stage Least Squares estimation procedure

AIC – Akaike Information Criterion

BERR – Department for Business, Enterprise, and Regulatory Reform

BIS – Department of Business Innovation and Skills

BRES – Business Register and Employment Survey

CfE – Centre for Entrepreneurs

CoL – City of London Local Authority District

EIP - Entrepreneurship and Innovation Programme

EU – European Union

GEM – Global Entrepreneurship Monitor

GOR – Government Office Region

HHI – Herfindahl-Hirschman Index

HTM – High Technology Manufacturing

IP – Intellectual Property

JSA – Jobseeker's Allowance

KBE – Knowledge Based Economy

KBI – Knowledge Based Industries

KIFS – Knowledge Intensive Financial Services

KIHTS – Knowledge Intensive High Technology Services

KIMS – Knowledge Intensive Market Services

KIS – Knowledge Intensive Services

KPF – Knowledge Production Function

KRE – Related Knowledge Entropy

KSTE – Knowledge Spillover Theory of Entrepreneurship

KUE – Unrelated Knowledge Entropy

LAD – Local Authority District

LISA – Local Indicators of Spatial Autocorrelation

LM – Lagrange Multiplier

LR – Likelihood Ratio

MAUP – Modifiable Areal Unit Problem

ML – Maximum Likelihood estimation procedure

4NN – 4 Nearest Neighbours spatial weights

8NN – 8 Nearest Neighbours spatial weights

nAch – Need for Achievement

OECD – Organisation for Economic Cooperation and Development

OKIS – Other Knowledge Intensive Services

OIR – Old Industrial Region

OLS – Ordinary Least Squares estimation procedure

QCO1 – Contiguous spatial weights based on the Queens Criterion of order 1

QCO2 – Contiguous spatial weights based on the Queens Criterion of order 2

SIC – Standard Industrial Classification

TEA – Total Entrepreneurial Activity

UKIPO – UK Intellectual Property Office

UN – United Nations

UNCTAD – United Nations Conference on Trade and Development

VAT – Value Added Tax

W – Wald Test Statistic

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Chapter 1 – Introduction

Modern growth theory emphasises the importance of direct knowledge inputs and knowledge spillovers in generating economic growth (Bishop, 2012; Glaeser, *et al.*, 1992; Romer, 1986; 1990; 1994). According to Mackinnon and Cumbers (2011), this growing emphasis on the importance of knowledge represents a transition in developed economies, whereby "capitalism has entered a new stage in which knowledge is the most important resource and learning the most important process" (Lundvall, 1994, cited in Mackinnon and Cumbers, 2011: 245). Accordingly, national governments and international organisations have sought to conceptualise the now more prominent role of knowledge in the modern economy from a systems perspective (Cooke and Leydesdorff, 2006), often termed the 'Knowledge Based Economy' (KBE): "economies which are directly based on the production, distribution and use of knowledge and information" (Organisation for Economic Co-operation and Development (OECD, 1996)).

Knowledge has a high propensity to spillover between firms and industries due to its non-excludability and non-rival characteristics (Arrow, 1962b) and the role of knowledge spillovers as a source of increasing returns to scale and endogenous growth is central to the KBE. Furthermore, the KBE develops a strong regional focus due to the fact that knowledge transmission across space is costly (Döring and Schnellenbach, 2006) and hence spatial proximity can reduce the cost of transmission. These insights have formed the basis of the 'New Economic Geography' (Krugman, 1991) characterised by local increasing returns to scale as a result of spatially bounded knowledge spillovers. This 'new regionalism' serves to emphasise the unevenness of the globalisation process (Mackinnon and Cumbers, 2011).

Knowledge spillovers can occur through a number of channels, such as labour mobility, social networks, and unintended communications (Bishop, 2012). However, recent literature has emphasised entrepreneurship as a source of knowledge spillovers, thereby driving economic growth and job creation (Audretsch and Feldman, 1996; Audretsch and Keilbach, 2007; 2008a; Bishop, 2012). Audretsch and Keilbach (2008a) argue that knowledge does not automatically translate into improved economic performance and competitiveness, providing empirical evidence showing how regional entrepreneurship capital has a positive influence on economic growth.

As a consequence of these arguments, national governments and international organisations have developed policies looking to encourage entrepreneurship and the competitiveness of small and medium enterprises (SMEs). For example, the Department for Business, Innovation, and Skills (BIS) in the UK highlighted the need to reform intellectual property (IP) legislation to "protect incentives for entrepreneurship and innovation, underpinning the dynamism the Government wants to see in the UK economy" (BIS, 2011). Similar policy initiatives have been enacted by the European Union (EU), through the 'Entrepreneurship and Innovation Programme' (EIP) (EU, 2014), and the OECD's 'Centre for Entrepreneurship, SMEs and Local Development'(OECD, 2014). This reflects the growing importance accorded to entrepreneurship in driving economic performance.

Theoretical and empirical evidence has confirmed that entrepreneurship is becoming increasingly relevant to the performance of KBEs. One important theoretical perspective that has emerged is the Knowledge Spillover Theory of Entrepreneurship (KSTE) (Acs, *et al.*, 2009; Audretsch and Keilbach, 2007). This approach posits that, due to the uncertain nature of knowledge, knowledge intensive incumbent firms are unlikely to appropriate the full potential returns from their innovation. This leaves a potentially valuable proportion of the ‘knowledge stock’ dormant; nascent entrepreneurs can capitalise on this and appropriate the returns from this knowledge through the creation of a new firm. However, this is not the only way in which knowledge can impact the entrepreneurial process. According to Cowan, David and Foray (2000), there is a growing practice amongst economists that juxtaposes ‘codified/explicit knowledge’, loosely defined as scientific or technical knowledge that is easily transmitted between individuals, against ‘tacit knowledge’, a form of knowledge that “has come to be more widely applied to forms of *personal* knowledge that remains UN-codified” (Cowan, David and Foray, 2000: 212, emphasis added). Tsoukas (2005) argues that treating tacit knowledge in ‘opposition’ to codified/explicit knowledge in a dichotomous manner is perhaps an oversimplification, in that tacit knowledge should be considered as complementary to codified/explicit knowledge as “its other side” (Tsoukas, 2005: 3). However, it does provide a useful conceptualisation of knowledge by suggesting that some knowledge is embodied within, and is unique to, individuals as a result of their human capital endowment and experience. This can manifest itself in the form of entrepreneurial ability (Schultz, 1975; 1980), a specific form of human capital that enables individuals to ‘deal with disequilibria’ and appropriate opportunities for profit. Thus, these two approaches to entrepreneurship similarly emphasise the important role of knowledge to the entrepreneurial process. Furthermore, these theories have a strong regional dimension, due to the costly transmission of knowledge over space, and the ‘regionalism’ of the KBE reflected by the spatial distribution of industry, people, and agglomeration (Mackinnon and Cumbers, 2011: 245-254).

Despite the relevance of these theories of entrepreneurship to the contemporary KBE, existing empirical evidence has a number of shortcomings:

1) There is little econometric research concerning the KSTE using sub-regional data.
2) Existing research concentrates upon the importance of the knowledge stock, issues pertaining to the nature and diversity of that stock have received less attention.
3) Measures of the regional knowledge stock have been typically measured using inputs into the knowledge generating process, particularly with UK data. Attempts at measuring regional knowledge stocks through an appropriate measurement of knowledge output have been very limited.
4) Research into the nature of entrepreneurial ability and its impact on regional entrepreneurial activity has been limited.
5) Most current research has not specifically addressed econometric issues arising from spatial autocorrelation. Whilst there have been a few exceptions (e.g. Bishop, 2012), spatial autocorrelation issues need to be more thoroughly examined through the use of spatial econometric techniques.

This thesis will address these shortcomings, providing a comprehensive empirical analysis of entrepreneurship in the knowledge based economy and making an original contribution in a number of areas. First, the empirical analysis will exploit a newly published (at the commencement of the project) dataset on Business Demography statistics compiled by the UK's Office of National Statistics (ONS). These new data replace existing official data on new businesses and have several advantages, including a more comprehensive coverage than previous VAT-based data. Second, the empirical analysis will develop new measures of regional 'knowledge stocks', taking a broader view of the nature of regional knowledge through the consideration of a wider array of factors influencing 'regional knowledge endowment'. Third, this thesis will provide an up-to-date empirical analysis of the role of knowledge and human capital in relation to regional entrepreneurship, updating much of the previous empirical research on the subject. Fourth, a research methodology based on advanced spatial econometrics will be used, applying spatial econometric methods and techniques in greater detail and more thoroughly than in previous research.

In order to fulfil this research agenda, this thesis will begin with a comprehensive overview of the role of entrepreneurship in economic theory, culminating in theories of entrepreneurship that can be considered central to the main tenets of the KBE. This is made difficult by the lack of a unanimously accepted, definitive theory of entrepreneurship within the economics literature, and the absence of a unifying and all-encompassing theoretical framework within which entrepreneurship fits into wider economic theory. Casson (2003) explicitly cites the limitations of the dominant schools of economic thought, the Neoclassical and Austrian schools, as major reasons for the lack of a definitive theory of entrepreneurship. Chapter Two will begin by exploring how entrepreneurship and its associated concepts are treated within the early economics literature, within the context of the development of economic theory from the eighteenth to the twentieth century. Chapter Three will analyse the contributions to entrepreneurial theory by several theorists and schools of thought that dissented from the mainstream approaches as they developed. Chapter Four will conclude the literature review through an examination of contemporary approaches to entrepreneurship. There will be particular emphasis on the KSTE and human capital approaches to entrepreneurship that provides the theoretical framework for the empirical analysis of this thesis. This chapter will conclude by providing an overview of entrepreneurship as considered in the economics literature, and the implications of this concept for the research to be conducted throughout the remainder of the thesis.

Following this discussion, the remainder of the thesis will examine entrepreneurship across Great Britain (GB) from 2008-2010 from an empirical perspective, utilising newly available data and spatial econometric methods. Chapter Five will examine the epistemological and methodological foundations, justifications, and implications of applying quantitative, econometric research methods to the study of entrepreneurship. This chapter will also provide an overview of the spatial econometric methods and data sources to be used. Once these philosophical and methodological foundations are established, Chapter Six will begin with an Exploratory Spatial Data Analysis (ESDA) of the Business Demography firm birth data across the pre-2009 Local Authority Districts (LADs) of GB. These data will be used as a dependent variable in the spatial regression analysis; hence, an in-depth analysis is required to investigate any potential outliers that could adversely influence the regression results, whilst also being useful to identify any spatial patterns that might be interesting to investigate from an econometric perspective.

Chapter Seven presents a spatial econometric analysis of the KSTE, utilising a range of original explanatory variables denoting regional knowledge, intellectual property, and a series of controls. Following the implementation of a series of Ordinary Least Squares (OLS) linear regression models, analogous spatial regression models which include spatially autoregressive components will assess the influence of spatial considerations on the regression results. Following this, Chapter Eight will analyse the relationship between human capital and entrepreneurship using identical OLS linear regression and spatial regression methods. These models will emphasise the role of education, experience, and ethnicity on the entrepreneurial process. Finally, Chapter Nine will summarise the empirical findings of the thesis, highlighting the main results and contributions to the field, some policy implications of these findings, and recommendations for future research. In doing so, this thesis will provide an extensive empirical analysis of entrepreneurship in the KBE.

2

Chapter 2 – The Role of Entrepreneurship in Early Economic Theory

2.1 – Introduction

The purpose of this chapter is to analyse the role of entrepreneurship in the earlier developments of economic thought. In order to provide an empirical analysis of entrepreneurship in the KBE, it is necessary to develop a useful and accurate definition of entrepreneurship and this will be achieved through an analysis of the role of entrepreneurship in economic theory. As will be seen, entrepreneurship has a long history in economic theory and, accordingly, it is prudent to conduct the analysis in a chronological fashion that shows how the considerations of entrepreneurship evolved alongside the development of economic thought.

First, Section 2.2 will look at the entrepreneur in the 'Mercantilist' era prior to the publication of Adam Smith's *The Wealth of Nations* in 1776, with a particular focus on the theories of Richard Cantillon (approx. 1680-1735). Second, Section 2.3 will analyse the role of entrepreneurship throughout the development of the Classical School of economic thought, with a particular emphasis on the considerations of Adam Smith (1723-90), JB Say (1767-1832), and John Stuart Mill (1806-73). Third, Section 2.4 will examine how the methodological approaches of the 'Marginalist Revolution', led in particular by William Stanley Jevons (1835-82) and Leon Walras (1834-1910), marginalised entrepreneurship as a field of mainstream economic enquiry. Finally, Section 2.5 will analyse entrepreneurship in the work of Alfred Marshall (1842-1924) during the establishment of the Neoclassical School of economic thought, explaining how a notion of entrepreneurship could exist within a neoclassical equilibrium framework. Where applicable, each of these sections will emphasise i) the entrepreneurial function as envisaged by each theorist ii) the personality traits and abilities required to effectively fulfil this function iii) the nature of risk and uncertainty in the entrepreneurial role iv) the role of profit as both an incentive for and return to entrepreneurship. Section 2.5 will conclude, highlighting common themes and the role of entrepreneurship in economic theory entering the twentieth century.

2.2 – 'Mercantilist' perspectives and the pre-Adam Smith Tradition

From approximately the middle of the fifteenth to the middle of the eighteenth centuries, an "inexorable process of economic, social, political, and cultural transformation" took place across Western Europe (Screpanti and Zamagni, 1995). This era of 'merchant capitalism', or 'mercantilism', saw a shift from previous feudal productive and political structures to one dominated by merchants who instigated a large increase in international trade. Even though a distinct era from an economic perspective, these three centuries of Mercantilism lacked an acknowledged spokesman that outlined a definitive mercantilist theory (Galbraith, 1987). It was not so much a 'system', but a loose coherence of particular policies implemented at the time; hence it is to the "policies and practices and not to the philosophers... that one looks" (Galbraith, 1987; Roll, 1992).

Several features characterised 'mercantilism' that distinguished the time from previous eras. In terms of dominant 'qualities of economic thought', Roll (1992:56) suggests that prevailing mercantilist attitudes included "a [preferable] attitude to selling, a 'fear of goods', the desire to accumulate treasure, and the opposition to usury". This resulted in "increasing commerce carried on both locally and over long distances" creating new markets of 'diverse aspect' selling "cloth, yarn, wine, leathers, shoes, corn and much else" (Galbraith, 1987: 32). The influx of precious metals resulting from voyages of discovery to the Americas and the Far East had a profound effect on commerce in Europe, most notably in the form of higher prices and an increase in the volume of trade (Galbraith, 1987: 33).

This period also saw the significant "appearance and consolidation of the authority of the modern state" (Galbraith, 1987). National wealth was equated with the accumulation of precious metals and resulted in national policies that could lead to a national accumulation of gold and silver, through advocating an export surplus and prohibiting the export of specie (Roll, 1992). The policies of the state generally reflected its common interests with wealth creating merchants. These merchants emerged from previous feudalistic years to become distinctive and affluent figures and if “operating on an adequate scale, an acceptable and socially prestigious one” (Galbraith, 1987); these were arguably the first ‘entrepreneurs’. Ultimately it was these merchants “that provided the state with the economic resources that sustained its internal and external power” (Galbraith, 1987) through ensuring the production of goods that could be exported. There was also the arrival of what was to become the “dominant economic institution today, the great modern corporation” (Galbraith, 1987). These groups of ‘Merchant Adventurers’ began to take a more ‘cohesive’ form throughout the mercantilist era and would undertake commercial enterprises of an entrepreneurial nature, sharing in the risks and proceeds from doing so. Thus, this period of time can be characterised by a prestigious and powerful class of wealth creating ‘merchant entrepreneurs’, conducting commercial trade to the material benefit of themselves and the state.

‘Domestic manufacturing’ was still dominant and occurred within the household, where the family unit was responsible for the production of what was required. Raw materials were supplied to the household by the ‘merchant entrepreneur’ and the labour of the household was paid, in the form of wage compensation, what was necessary to command the finished goods; these goods were then sold at market by the ‘merchant entrepreneur’ (Galbraith, 1987). Given this context, Richard Cantillon (approx. 1680-1735), widely regarded as the first to pay ‘considerable attention’ to entrepreneurship (van Praag, 1999), understandably emphasised the coordinating feature of entrepreneurship, as merchant entrepreneurs acted as the intermediary between the productive unit of the household and the market place. This coordinating feature was essential in a decentralised production system if markets were to be supplied efficiently. To Cantillon, entrepreneurship was at the centre of the economic system, ultimately responsible for ‘all the exchange and circulation in the economy’ in a self-regulating market of reciprocal exchange (van Praag, 1999). The merchant entrepreneur operated as the medium between the capitalists, landowners, and labour to facilitate exchange, and there is a clear acceptance that these entrepreneurs were a vital 'class' of economic agent.

The 'merchant entrepreneur' would bear the risk involved with coordinating production, as they would bear the cost should the raw materials be lost in the production process or if there were no demand for the finished goods. 'Judgement, alertness and a forward looking nature' (van Praag, 1999) would be required by the merchant entrepreneur to ensure that the supply of goods would fit demand. Antonio Serra, another prominent theorist of the time (Roll, 1992), also highlighted the 'quality of the population' as a means through which a nation can accumulate wealth, and this quality involved "diligence, ingenuity, and a spirit of enterprise" (Roll, 1992: 62). In using these necessary qualities to successfully manipulate discrepancies between the supply and demand for goods, it is clear as to why Cantillon related entrepreneurship primarily to arbitrage (van Praag, 1999). Through this process, Cantillon's entrepreneur faces an income which is uncertain, and it is this uncertain, non-contractually agreed income and its "risk bearing nature" that becomes the 'distinguishing feature of the entrepreneurial task'. Hebert (1985) explicitly asserts that the "most consistent picture of the entrepreneur that emerges from Cantillon's writings is that of a person who faces uncertainty and bears the risk of that uncertainty in the marketplace." This emphasis on risk as a key feature of entrepreneurship features heavily in later theory. For example, John Stuart Mill emphasised calculating the 'risk of entry' as an important aspect of entrepreneurial decision making in competitive markets (Black, 1986). Similarly, psychological approaches to entrepreneurship, discussed in Section 4.2, look to analyse whether a person's willingness to bear risks determines their propensity to become an entrepreneur. Many theorists, with the notable exception of Schumpeter, envisage risk as an important, if not defining, feature of entrepreneurial behaviour and its origins can be found in Cantillon's (1755) work.

A prominent feature of this period of 'merchant capitalism' was the preoccupation with the accumulation of gold and silver, and accordingly a "merchants stock of precious metals was in that time the relevant index of his personal wealth, the simple, forthright measure of his financial competence" (Galbraith, 1987). What was right for the individual was also considered right for the whole, as this was also the appropriate measure of wealth for the state. The persistent nature of warfare among rival states at the time necessitated a national policy to accumulate silver and gold in order to fund conflict. This preoccupation with the accumulation of precious metals is reflected in Cantillon's belief that profit is the incentivising factor for entrepreneurial behaviour and the measure of entrepreneurial success, achieved through a process of "buying at a certain price and selling at a higher price" (van Praag, 1999). Thus, in this early approach to entrepreneurship, profit is considered as a surplus of revenue over cost and necessary for the entrepreneur to continue trading. By relating entrepreneurship primarily to arbitrage in this way, Cantillon suggests that entrepreneurship is purely a risky, financial profit seeking activity.

In summary, the early emergence of entrepreneurial theory can be found in Cantillon's (1755) work, written in an era of merchant capitalism. Cantillon stressed that the merchant entrepreneur was both a coordinator and arbitrageur, emphasising the bearing of risk and the profit incentive required to induce entrepreneurial behaviour. The accumulation of precious metals was the measure of wealth for both the state and the merchant entrepreneur, highlighting how entrepreneurship reflected the prevailing attitude of the time.

2.3 – Adam Smith and the Development of Classical Economic Thought

It is well established that Adam Smith's (1723-1790) "An Inquiry into the Nature and Causes of the Wealth of Nations" is a defining moment in economic thought (Deane, 1978; Galbraith, 1987; Screpanti and Zamagni, 1995). Written in 1776 at a time of "critical importance for the history of Europe and the history of economic thought" (Screpanti and Zamagni, 1995: 43), this "most climactic assault of ideas on policy brought the mercantilist era to an end" (Galbraith, 1987). The preceding years of the Enlightenment supplied the 'philosophical bases' for an assault on the prevailing mercantilist attitudes of the time (Screpanti and Zamagni, 1995). Several technological innovations occurred around the same time, providing an opportunity to produce goods in a different manner and on a much larger scale, an "important precondition for the take-off of the Industrial Revolution" (Screpanti and Zamagni, 1995: 44). There is a debate as to whether this industrial revolution was the result of 'fortuitous episodes in innovation' or the product of 'inspired entrepreneurship', the "predictable achievement of those who, with brilliance and inspiration, perceive the possibility of change" (Galbraith, 1987). Here, Galbraith (1987) is echoing Joseph Schumpeter, who perceived entrepreneurship as the instigation of changes in processes of production. Nonetheless, the entrepreneurship described by Galbraith (1987) is arguably responsible for the most spectacular process of industrial change in history.

This process, which "came to England and Southern Scotland in the final third of the eighteenth century, brought into the factories and factory towns the workers who had previously been producing goods in their cottages or food and wool on their farms" (Galbraith, 1987). Consequently, a great centralisation of production occurred, the direction of which now involved an important organisational dimension. Productive entrepreneurship now entailed the direction and control of resources within a factory setting and the head of the factory became responsible for the output from the labour and capital under their command. Thus, it is understandable that Say, and later Marshall, added a managerial function to accompany an entrepreneurial one (Koolman, 1971; van Praag, 1999; Zaratiegui, 2002). Production was no longer only dependent on 'merchant entrepreneurs' coordinating resources across decentralised productive units, but also on the effective management of resources in a centralised factory setting: "instead of being mere merchants, buying cloth from the weavers and selling it in markets or at fairs, they set-up workshops that they supervised themselves. They were manufacturers in the modern sense" (Galbraith, 1987: 58). As the entrepreneur then became the director of capital and labour, it is understandable that the entrepreneurial function would become entwined with that of capitalists and managers. To further highlight this, Galbraith (1987) suggests that interest, the return for the capitalist, and profit, commonly understood as a return to entrepreneurship, were not clearly distinguished in Smith's work. The dominant figure in this new industrial process was no longer "the merchant, whose orientation was to the purchase and sale of goods, but the industrialist, whose orientation was to their production" (Galbraith, 1987). This 'dominant figure', perhaps encapsulating the essence of entrepreneurship, becomes more intimately involved in productive processes than was previously seen in Cantillon's coordinating arbitrageur.

Smith's treatment of profit is somewhat ambiguous. He envisaged a "normal profit for entrepreneurial activity", and in his macroeconomic theory of surplus, profit is a residual income; however, his microeconomic theory of competitive equilibrium considered profit as remuneration for risk (Screpanti and Zamagni, 1995: 62). This second approach concerned individual agents as opposed to collective social classes and an example is given that seems decidedly entrepreneurial: the capitalist owner who decides to "transfer investments from one market to another in search of a higher profit rate" (Screpanti and Zamagni, 1995: 62). Roll (1992) elaborates further, highlighting that "when [capital stock] has accumulated in private hands its owners will employ it to set to work 'industrious people whom they will supply with materials and subsistence in order to make a profit by the sale of their work'"; were there no profit to be had, "the owner of the stock would have no interest to employ it" (Roll, 1992: 144). Thus, Smith envisaged something decidedly entrepreneurial about the employment of capital and profit is seen as an incentive to reallocate capital. It is unclear whether interest and profit are synonymous here, such that the entrepreneurial and capitalist functions become somewhat confused.

Economics took its longest step forward with Adam Smith and three 'great figures' emerged to refine and extend his work, J.B Say, Thomas Malthus and David Ricardo (Galbraith, 1987); of these, J.B. Say discussed entrepreneurship to the greatest extent. Galbraith (1987) suggests that his celebration of "the distinctive, even decisive, role of the entrepreneur" stemmed from his business background, and the entrepreneur is described as "the man who conceives or takes charge of an enterprise, sees and exploits opportunity and is the motive force for economic change" (Galbraith, 1987). Say gave a central role to the entrepreneur in the production and consumption of goods (van Praag, 1999):

> "Those, which have at their disposal any one of these three sources of production [industry, capital, labour], are the venders of what we shall here denominate productive agency and the consumers of its products are the purchasers... The wholesale employers of industry [entrepreneurs d'industrie] are but a kind of brokers between the vendors and purchasers, who engage a quantum of productive agency upon a particular product, proportionate to the demand for that product. On the other hand, agents of production... land, capital and human labour, are supplied in larger or smaller quantity, according to the action of various motives... thus forming the other bases of the value at which their agency is rated." (Fontaine, 1999: 2)

This reveals the entrepreneur's role as the principal coordinator of production in the economy. The entrepreneur hires productive agents in return for rent, wages and interest and combines them in order to meet the demands of final consumers (Koolman, 1971). They are the principal coordinator within the firm and are also responsible for coordinating the allocation of factors at market level; they are the 'linchpin' "holding together landlord and capitalist, technician and labourer, producer and consumer" (Koolman, 1971). This is achieved through "the application of knowledge to the creation of a product for human consumption" (van Praag, 1999) within and across each of the value creating sectors of an economy; agriculture, industry and commerce.

Say's entrepreneur is also responsible for the distribution of returns to land, labour, and capital that are derived from his utility theory of value, as "value in exchange was an expression of subjective estimates of utilities in terms of quantities" (Roll, 1992: 291-292). Factors have value because they supply productive services, and this value is "derived from the value of their products". It is the entrepreneurs that provide the connection between the value of products and the derived value of factors: "entrepreneurs provide the link between factor and product markets... the intermediaries who demand the productive services required for a product in relation to the demand for the product" (Roll, 1992: 293). Therefore, it would seem that production and distribution necessitates entrepreneurship in Say's conception of the economy. This retains the coordinating nature of entrepreneurship identified by Cantillon and also the importance of entrepreneurship to the aggregate production of goods and services, but the centralisation of production which occurred at the time is reflected in the entrepreneur beginning to hire and manage factors of production.

Risk and uncertainty are again inherent in this entrepreneurial process, as entrepreneurs are still liable to pay wages and rent should the entrepreneur's judgement concerning sales have proven erroneous; similarities with Cantillon's conception are evident (van Praag, 1999). To manage this risk appropriately and ensure the attainment of profits, entrepreneurial activity requires certain characteristics. Van Praag (1999) highlights 'judgement, perseverance, knowledge of the world and business, superintendence and administration' (Say 1803, cited in van Praag, 1999) as the requisites for successful entrepreneurship, as well as 'experience within and knowledge of the occupation'. Both Fontaine (1999) and Koolman (1971) reiterate judgement as the 'chief moral quality' required to deal with risk and uncertainty.

Profit remains the incentive to bear the risks involved with entrepreneurship and the abilities required and the risk involved in entrepreneurship ensures that the supply of entrepreneurs is limited. According to van Praag (1999), this ensures that the price of entrepreneurial supply remains high and "it is this class of producers… which accumulates the largest fortunes" (Say, 1803, cited in van Praag, 1999). Within the context of the firm, the remuneration to entrepreneurship is the profit from business activities: turnover minus payments to inputs. Thus, profit is both a surplus from the production coordinated by the entrepreneur, as well as a return to the superior judgement and abilities required for successful entrepreneurship. This latter theme, that profit is a return to superior ability, finds precedence in theories of entrepreneurship that are prominent in the latter part of the twentieth century. The traits approach of psychology based entrepreneurial theories, discussed in Section 4.2, theorises that the presence of certain cognitive attributes determine entrepreneurial tendency. Schultz (1975; 1980) similarly emphasises the role of entrepreneurial ability; however he develops this concept further by treating it as a scarce resource within an equilibrium framework, where the supply of entrepreneurial ability can be increased through investment in education within the population. The nature of profit is also extended by Schultz (1975; 1980), as he includes non-pecuniary returns, such as the saving of time, as a form of entrepreneurial profit; profit in Say's entrepreneurial theory is clearly financial. In all, Say's economic thought has a central place for entrepreneurial processes in coordinating production and he attributes many personality traits to the entrepreneur to fulfil this role. Profit is seen as both a surplus from production and a return to abilities from entrepreneurial activity.

Described as the "last in the line of major English philosopher-economists in the tradition of Adam Smith" (Deane, 1978: 91), John Stuart Mill (1806-73) attempted the daunting task of unifying aspects of the economic thought that preceded him, particularly the macroeconomic theory of surplus and the theory of individualistic competitive equilibrium (Screpanti and Zamagni, 1995). Unfortunately, "once the classical era had closed, his work was almost completely forgotten" (Screpanti and Zamagni, 1995) and Hollander (1986) believes that his possible 'undervaluation' has been at a great cost to economic thought.

Mill had a place for entrepreneurship in his economic theory. In particular, Mill emphasised the role of the entrepreneur in price formation and defined cost in terms of "remuneration paid to labourers and suppliers of capital", which necessitates "approaching the problem from the angle of the entrepreneur" (Roll, 1992: 332). This is possibly because the remuneration paid to labour in the production process can be conceived as a business decision of an entrepreneurial nature made by the head of the firm. This form of business decision making is described by Hollander (cited in Black, 1986: 140) in the event of a technological advance that reduces 'natural price':

"Mill's approach allows a price-setting role to individual (competitive) entrepreneurs who, aware of the likelihood of entry into the industry by firms in response to super-normal profit, act to forestall them. It is, therefore, not [an] increase in supply that works to reduce price to the lower cost level, but price that is lowered directly, at a rate depending upon the estimate of the immediate danger of entry made by existing entrepreneurs who calculate the risks of entry as viewed by prospective entrants, a calculation which turns partly upon demand elasticity" (Hollander, cited in Black, 1986: 140)

The preceding extract shows the relevance of entrepreneurial behaviour to Mill's conception of prices in competitive markets. First, the extract highlights the role of profit as the incentive to entrepreneurial behaviour. Profits act as a signal to nascent entrepreneurs indicating that entry into that particular market is likely to be a profitable activity and thus entry is encouraged; uncertainty regarding the potential success of a venture is reduced by the presence of high profits. Second, the extract suggests that a key component of entrepreneurial behaviour is a desire to gain a strategic advantage over both existing and potential competitors; existing 'individual (competitive) entrepreneurs lower price towards cost in order to discourage potential entrants. Furthermore, this illustrates the mechanism through which the 'invisible hand' of competitive market forces can exert itself in order to reach equilibrium in the market where price is equated to cost, namely through the conscious decision making on the behalf of alert entrepreneurs; it is not so much the invisible hand that determines prices, but the much more visible entrepreneur. Third, the extract alludes to the process by which entrepreneurial decisions are made. Specific mention is made of entrepreneurs who 'estimate danger' and 'calculate the risk of entry'; clearly, forming perceptions of possible future realities and acting accordingly in order to maximise expected profit forms an essential part of entrepreneurial decision making. This retains the element of risk, and the judgement and foresight that is required to estimate risk, that is present in both Cantillon's and Say's conceptions of entrepreneurship. Finally, Mill's conception of entrepreneurial action in price formation alludes to how entrepreneurship is an important process in determining prices, output, and equilibrium; the centrality of entrepreneurship to the functioning of markets and determining productive output is a feature shared by Mill with the classical authors that preceded him.

Mill's conception of entrepreneurial decision making encapsulates elements that can be related to other approaches to entrepreneurship. The fact that profits act as a signal to potential entrepreneurs that works to reduce the uncertainty they face can be applied to the nature of uncertainty in the KSTE, discussed at length in Chapter 4, Section 4.4. Here, incumbent firms are likely to be uncertain of the potential value of their innovation and are thus conservative in the appropriation of this innovation, creating opportunities for nascent entrepreneurs to exploit. Mill's entrepreneurial framework seems to suggest is that the profit of potential competitors encourages innovation and entrepreneurship by reducing the uncertainty surrounding similar innovative activity. This creates is an image of a world where 'waves of innovation' occur in a systematic way, similar to how Bewley (2001) describes the role of Knightian uncertainty, discussed later. Furthermore, these insights might also highlight a particular role for the Schumpeterian entrepreneur; any innovation that is sufficiently radical will necessarily require an ambitious, risk loving entrepreneur to appropriate its returns, as knowledge of profits from similar activities that might act to reduce uncertainty would not be forthcoming.

Thus, it can be seen from the preceding analysis that the classical authors, from Adam Smith, J.B. Say and through to John Stuart Mill, considered entrepreneurship, and the associated concepts of risk and profit, as key components of their economic theories. Risk and uncertainty feature prominently in much entrepreneurial theory, receiving its fullest treatment from Frank Knight who is discussed in Chapter 3, Section 3.3. The preceding analysis of the classical authors, as well as Cantillon, shows that the importance of risk and uncertainty to the entrepreneurial process is recognised in the earliest economic theory. Profit also features very prominently in this early theory and is typically defined by the classical authors in monetary terms as a surplus of revenue over cost. The reasons why entrepreneurs are able to extract this surplus can, according to Say in particular, be envisaged as a return to their superior judgement, intelligence, and ability to organise production. Whilst profit is typically considered by the classical authors as financial remuneration, entrepreneurial frameworks such as Mill's can be extended to incorporate the maximisation of other, perhaps more abstract, 'returns' such as utility. This particular aspect of entrepreneurial theory was advanced by both Schumpeter, who emphasised more psychological 'returns' to entrepreneurship, and Schultz, who emphasised a wide variety of potential 'returns' to entrepreneurship.

2.4 – The 'Marginalist Revolution' and Neoclassical Economic Thought

Throughout the period 1840-1873, there was a rapid expansion in economic development across England, continental Europe, and the United States characterised by a surge of industrial growth, revolutionary changes in transportation and communication, further industrial concentration, and the consolidation of the position of the limited company (Hunt, 1979; Screpanti and Zamagni, 1995). By 1870, "liberal capitalism was beginning to take a more modern form (Hunt, 1979) and shortly after, a substantial shift in economic thought occurred in the early 1870's that is widely referred to as the 'Marginalist Revolution' (Deane, 1978; Roll, 1992; Screpanti and Zamagni, 1995).

This revolution in economic thought was led by the "celebrated trinity" (Roll, 1992) of William Stanley Jevons (1835-82), Carl Menger (1840-1921) and Leon Walras (1834-1910), each of whom released their *opus magnum* in the early 1870's. The major development in economic thought that came from this work was the theoretical establishment of a subjective theory of value and the concept of 'diminishing marginal utility', arrived at independently by Jevons, Menger, and Walras[1]. The principle of diminishing marginal utility appeared to resolve the paradoxical nature of value in use and value in exchange that had been problematic for the Classical economists (Galbraith, 1987: 108). This represented a substantial shift from the earlier classical attempts that sought to develop an objective theory of value based on labour cost (Hunt, 1979). The main aspect of these developments relevant to the role of entrepreneurship in economic theory concerns their impact on economic methodology. A subjective theory of value based on individual marginal utilities engendered a rationalist, individualistic methodological approach based on egotistical and hedonistic conceptions of human behaviour rooted within utilitarian philosophy (Hunt, 1979; Roll, 1992; Screpanti and Zamagni, 1995). Individuals were conceived as rational utility maximisers, "comparing utility ratios to price ratios, and

[1] See Deane (1978: 93-124), Hunt (1979: 236-270), Galbraith (1987: 89-125), Roll (1992: 336-380) and Screpanti and Zamagni (1995: 145-183) for further discussion on the subject, from which much of the information here is sourced.

adjusting their purchases so as to attain a 'maximum of pleasure'" (Hunt, 1979). Exchange would occur until marginal utilities were equalised across all products and services, where a determined equilibrium would be reached and further exchange would no longer be desired.

The role of entrepreneurship in economic theory was affected by the new subjective, individualistic approach in two main ways. First, there was a "disappearance of interest in economic growth, the great theme of the economic theories of Smith, Ricardo, Marx, and all the classical economists"; the founders of the neoclassical system simply 'did not consider' the forces that were responsible for the 'evolution of industrial economies' (Screpanti and Zamagni, 1995: 147). As a creative instigator of changes in productive forces, the entrepreneur found a decreased role in this new economic thought. Furthermore, the individualistic reductionism of the marginalist approach led to the elimination of social classes in economic theory and obviated the need for discussion of the development of social relations, a key feature of the classical economists and Marx (Screpanti and Zamagni, 1995: 149). The "deletion of concepts... of 'social class', 'labour power', 'capitalism', 'exploitation', 'surplus' etc." was driven by a desire for a reinvention of economic science in the face of socialist criticism from Marx that did not seem too ideological, instead focusing on the scientific foundations of classical economic theory (Screpanti and Zamagni, 1995: 154). Introducing a subjective theory of value and the concept of marginal utility enabled this development, by presenting a view of market relations where the harmony of interests and maximisation of individual objectives could be mutually attained without the class antagonism characteristic of the classical and Marxist systems. Unfortunately entrepreneurs as a social class, a key component of the capitalist process who were necessarily associated with concepts of surplus and profit, found a lesser place in this new system.

The application of methodological individualism also enabled the statement of generalised axioms of human behaviour routed within hedonism and egoism that were capable of mathematical expression. The entrepreneurial decision makers that characterised earlier economic theory were replaced with one homogenous category of rational utility maximisers: the consumers (Screpanti and Zamagni, 1995: 167). According to Hunt (1979: 289-291), this new economic process consisted of egotistic, rational, utility-maximising individuals, exchanging their factors of production for the consumption of goods in a continuous process until their utility is maximised. Consequently, when combined with the generalised egotistical and hedonistic axioms of human behaviour, this denatured human choice to the extent that consumption decisions became determined by the relative prices of goods and a matrix of subjective utilities derived from the consumption of such goods. The same methodological approach was also applied to the firm, which had an analogous decision making process whereby the firm would combine factors, instead of consuming goods, to produce an output that maximised profit, as opposed to utility. This is far removed from the creative entrepreneurial decision making involving judgement and foresight conceptualised in the competitive market processes that characterised the work of Say and Mill, for example.

Furthermore, as these generalised principles of human behaviour were capable of mathematical expression, this led to the development of economic calculus by Jevons and Walras (Deane, 1978). Walras is perhaps best remembered for establishing General Equilibrium theory, an elegant mathematical construct theoretically demonstrating that a set of prices will always be obtained at which all markets clear when ‘certain conditions’ are fulfilled (Roll, 1992: 360). Criticism of the realism of the necessary ‘certain conditions’ and strict assumptions of hedonistic, calculating, utility maximising behaviour often feature in the discussion of the appropriate role of economic science (Robbins, 2007); however this axiomatic and deductive form of reasoning came to dominate economic thought as the Neoclassical School and had a profound effect on the role of entrepreneurship in microeconomic theory in particular. Deductive mathematical models have a logically consistent ‘optimal’ solution, essentially predetermined by the initial conditions of the market and rational maximising behaviour of market participants, where welfare is maximised. This lessens the need for a theory regarding the decision making and adjustment processes of market participants, which constitutes an integral part of the entrepreneurial role in competitive markets. The methodological approach of the marginalists resulted in the entrepreneurial processes within competitive markets becoming subservient to the initial conditions, assumptions, and the outcomes of the models; it was no longer the process of adjustment, but the characteristics of the solution that became the focus. This is in contrast to the earlier classical scholars who emphasised that "the mechanism of the market required ultimately to be explained by more fundamental concepts, either relating to human conduct or derived from a view of society and its historical development" (Roll, 1992: 339).

Despite being a pioneer of this method, Walras still used terms such as 'capital, interest, entrepreneur, and wages', terms that only make sense in reference to the classical capitalist system (Screpanti and Zamagni, 1995: 149). Walras makes explicit reference to entrepreneurs, even declaring "the definition of the entrepreneur is, in my opinion, the key to all economics" (Walker, 1986). However, Walras' use of the term entrepreneur seems to differ from its earlier application. Entrepreneurs are 'mere' coordinators, organising productive activity and taking prices and inputs as given (Screpanti and Zamagni, 1995: 149). Walrasian entrepreneurs respond to the existence of profit and loss according to the rule: increase the scale of supply when there is a profit and decrease it when there is a loss.

There would seem to be elements of Say's factor coordinator, Cantillon's arbitrageur, and notions of profit as a residual of the entrepreneur's activity in Walras' use of the term; however, further inspection lessens the significance of the Walrasian entrepreneur somewhat. Profit, still the residual of entrepreneurial activity, is supposed to exist only when markets are in disequilibrium; as profits are zero in equilibrium, "profit depends on exceptional circumstance" and "from a theoretical viewpoint, it must simply be ignored" (Screpanti and Zamagni, 1995: 167). Walras argued that "the choice to become an entrepreneur is purely accidental... They make their living not as entrepreneurs, but as land-owners, labourers and capitalists"; accordingly, "the socioeconomic identity of the entrepreneur is completely irrelevant" as they receive their income as capitalists, landowners, and labourers (Screpanti and Zamagni, 1995: 167). Thus, whilst Walras developed some conception of entrepreneurship, it has been argued that they have an ‘accidental’ function and an ‘irrelevant’ identity in his economic theory. Hunt (1979: 289-291) describes the role of the Walrasian entrepreneur as “strange and contradictory but absolutely necessary”, assigning them an almost mystical role. These entrepreneurs play one half of the fictional *deus ex machina*, the other being Walras’ auctioneer that, along with “unrealistic assumptions about people, production functions, and economic institutions” (Hunt, 1979: 290), allows Neoclassical equilibrium theory to actually work:

> “If there ever was a modern-day counterpart to the myth of Sisyphus, it is the neoclassical myth of the entrepreneur. As we saw in Walras’ theory, the entrepreneur is the organiser of production. He is a classless entity, who may be a capitalist, a worker, or a landlord… There are, of course, real entrepreneurs in capitalism, but the entrepreneurs of neoclassical theory are purely mythical entities. Such entrepreneurs are perpetually motivated by the quest for profit. But in the neoclassical version of competitive equilibrium, there are no profits. So the neoclassical entrepreneur is perpetually scheming, worrying, buying, and selling in the quest for an illusory, chimerical will-o’-the-wisp” (Hunt, 1979: 290-291).

The Neoclassical paradigm came to dominate conventional economic thought throughout the twentieth century and this ensured that this esoteric form of entrepreneurship would supplant the earlier classical conceptions of entrepreneurship rooted in observation and realism. The related concepts of marginal utility and a subjective theory of value established in the ‘Marginalist Revolution’ resulted in the marginalisation of entrepreneurship as a field of mainstream economic enquiry.

2.5 – Alfred Marshall

Given the tradition started by Jevons and Walras, it might seem contradictory to suggest that Alfred Marshall (1842-1924), often considered as a founder of the Neoclassical School, would emphasise entrepreneurship in his economic theory. However, Marshall “tended to favour realism and the explanatory power of the theory, rather than the logical coherence and formal elegance of its results” (Screpanti and Zamagni, 1995: 178).

He developed partial-equilibrium analysis as an "alternative theoretical outlet to that proposed by Jevons" and this was his "great invention and personal contribution to economics". By concentrating on the equilibrium conditions of single markets, using concepts of 'industry' and the 'representative firm' as analytical instruments, Marshall offered the Neoclassical School a "wider cultural perspective" for the 'intelligent common man' (Screpanti and Zamagni, 1995: 178). It is quite indicative of the relevance of entrepreneurship to economic reality that a theorist who sought realism and explanatory power in his theory would also emphasise the role of entrepreneurship. It was Marshall's belief that "economics is a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of wellbeing" (Robbins, 2007: 1). This approach must necessarily include entrepreneurship.

To Marshall, entrepreneurship was central to the economic process. Reminiscent of Say's theory, the entrepreneur is responsible for the supply of commodities through recognising profitable opportunities, whilst creating his own opportunities through innovations and progress, a function that conferred many benefits onto society (van Praag, 1999). Perhaps foreshadowing Schumpeter, Marshall also emphasised the importance of entrepreneurship to industrial development and economic progress, suggesting that "progress [had] been affected on the practical side by those businessmen, who have been alert to invent or adopt new ideas; to put them into practice, bearing the risk of loss" (Marshall, 1919, cited in Zaratiegui, 2002: 461). He warned of the 'danger' of decline in standardised industry, where these "faculties of initiative" are substituted, or 'overshadowed', "by the more commonplace faculties of orderly administration and commercial skill" (Zaratiegui, 2002: 415). Zaratiegui (2002) argues that Marshall distances himself from Schumpeter in attributing to the entrepreneur "talent and genius without him being a superman"; however the similarities between Marshall's and Schumpeter's conceptions of the influence of entrepreneurship on economic progress seem more striking than the differences.

Similarities between Marshall and Say are also apparent in Marshall's development of a dichotomy consisting of entrepreneurial and managerial functions, which fulfil different roles and relate differently to uncertainty and risk. The entrepreneurial role is to "look far ahead, estimate chances and balance risk" (Marshall, 1919, cited in Zaratiegui, 2002), ensuring that the business acts with 'energy' in the 'face of challenges without losing its verve for the future'. This is key to the success of the firm and defines the firm's competitive position, and it is the responsibility of the entrepreneurial role to "identify opportunity in the midst of adversity and create an organisation designed to take full advantage of such opportunities" (Zaratiegui, 2002). The entrepreneur is the creative figurehead of the profit-maximising firm and is ultimately responsible for its profits. The managerial function involves ensuring the 'continuing performance of the firm' (Niman, 1991, cited in Zaratiegui, 2002), responsible for decisions based within existing market and organisational structures; this requires a passive attitude and those fulfilling the managerial role do not need to use initiative to seek change. Marshall viewed the personal qualities required for each function as quite distinct; the entrepreneurial role requires creativity and foresight to conceive ideas for the firm to capitalise on, whereas managers are responsible for executing these ideas through utilising their administrative and commercial skill within existing firm structures. However, these functions are not mutually exclusive categories and both functions, and their required qualities, can be present in one person or distributed amongst many within the firm. Perhaps driven by his desire for 'realism', Marshall suggests that each 'businessman' can perform one or more of these functions at any given time. This is an important aspect of the role of entrepreneurship in economic theory, as it implies entrepreneurship is a form of behaviour, as opposed to a distinct class of individual in the productive process.

The distinction between functions is important when considering the nature of risk and uncertainty; both the manager and the entrepreneur face uncertainty, but the nature of this uncertainty differs. Salaried managers bear no risk aside from the risk involved with the possible loss of employment and prestige, whereas the entrepreneur assumes the principal risk of the business, enjoying the uncertain profits that may ensue (Zaratiegui, 2002). The nature of the Marshallian ‘businessman’ becomes more elaborate when considering the source of capital for the firm, principal-agent problems stemming from the divorce of ownership and control, and how this affects the various incentives, risks, and uncertainties within the firm (Zaratiegui, 2002). Marshall argues that it is the one who supplies capital and also assumes the entrepreneurial function that bears the most risk involved in business, as he is liable to lose everything; conversely, one who assumes the entrepreneurial role and works with borrowed capital will surely “lose less” than the supplier of capital if the venture fails (Zaratiegui, 2002). In this latter instance, an element of the risk involved with the venture is borne outside of the firm. Perhaps because of this, the entrepreneur who also supplies capital has the highest incentive to maximise profits and the most interest in the success of the firm.

Marshall insists that it is important to make the ‘distinction between talent and money’ and the interest accrued on capital should not be considered an element of entrepreneurial profit (Zaratiegui, 2002). Marshall distances himself from Walras by making a clear distinction between profit and the returns to other factors. The capitalist who supplies his capital to the entrepreneur, as opposed to trading with it himself, has chosen interest over profits and can be accused as having “more cash than dash” (Reisman, 1988, cited in Zaratiegui, 2002). The scarcity of entrepreneurial talent, a concept explored in greater detail later and which consists of intelligence, general ability, and specialised ability in the form of trade knowledge and forecasting skill (van Praag, 1999), ensures that entrepreneurs receive high profits and explains the observed wealth of many entrepreneurs. It is suggested that the managerial function is not as ‘vital’ as the entrepreneurial role, as the managerial function can be purchased in the market like any other factor of production (Zaratiegui, 2002). Thus, the return to the managerial function is a certain wage, further highlighting the theoretical difference between profit and returns to other factors.

Here is perhaps the conflict between Marshall’s approach and the neoclassical conceptions of Walras, namely the presence of profit as a distinct return within the system:

"Most of the classical economists and Marx had defined profit as a residual surplus left after the capitalists paid all the necessary costs of production. Neoclassical economics retained this definition as a residual over and above costs. But in neoclassical competitive equilibrium*, all income results from payments to the necessary costs of production. There is no residual; there is no surplus; and there is no profit*" (Hunt, 1979: 289, original emphasis)

A world with no profit would imply that the Marshallian entrepreneur cannot exist and has no incentive to pursue his task. However, the resolution of this contradiction between the Marshallian entrepreneur and neoclassical general equilibrium theory lies in Marshall's analytical apparatus. Specifically, he considered different time periods regarding value and price formation, in the form of market values in the very short run, and normal values over both the short and long run:

"Marshall's apparatus is elaborate because of the purpose for which it is devised. By making possible the distinction of different degrees of adjustment, it becomes capable of application to concrete problems. This 'step by step' or 'partial equilibrium' method was not perhaps different in kind from the general equilibrium analysis of Walras. But it was designed for different, more realistic aims" (Roll, 1992: 365)

Thus, Marshall's partial equilibrium approach distinguishes his analysis from Walras', allowing room for the Marshallian entrepreneur to exist; allowing variability in the supply of factors, in part determined by price, made "his apparatus to be more suitable to dynamic problems" (Roll, 1992: 368). Marshall emphasised that even in the long run, "earnings of the factors of production were not identical with their real costs of production. That could only be true when general equilibrium has been reached, that is in the *unreal* world of the stationary state" (Roll, 1992: 366, emphasis added). Market forces continually tended towards equilibrium, but its actual attainment was an unrealistic possibility (Roll, 1992); therefore, opportunities for profit always persist along with the Marshallian conception of entrepreneurship. This can be contrasted with the 'Sisyphean' entrepreneur in Walras' conception of general equilibrium (Hunt, 1979: 289-291).

Roll (1992: 368) describes Marshall's economic theory as "a most fruitful kind for subsequent development in the apparatus of economic analysis and in the evolution of practical aids to statesmanship." His analytical genius allowed his theory to be of practical use to the layman, and this task was undoubtedly helped by his retention of entrepreneurial concerns in economic processes and his desire for his theory to accurately depict the behaviour of the real business world.

2.6 – Conclusion

The preceding analysis highlights the various conceptions of entrepreneurship in early economic thought. Driven by a desire for realism, the earlier economic theorists, Cantillon, Say, and Mill in particular, paid great attention to the role of entrepreneurship in economic affairs. The attempts at defining entrepreneurship from Cantillon and Say emphasised the allocation of resources and factors of production to produce goods for human consumption at a price higher than the cost of resources and factors; profit here is a residual to reward the productive activities of the entrepreneur. Mill, however, emphasised the nature of entrepreneurial decision making in competitive markets. As the figureheads of firms, entrepreneurs within these competitive markets would make decisions regarding price, output, and potential entry, calculating risks in order to gain a competitive advantage. It is difficult to isolate a unifying theme in this work beyond suggesting that, to these authors, entrepreneurship involves some form of decision making process concerning the allocation of resources in order to obtain an uncertain profit. Profit can be conceptualised as being in a better position, which may be financial should revenues exceed costs (Cantillon, Say) or in a stronger strategic position in a competitive market (Mill). Furthermore, all of these approaches, as well as Marshall's, suggest that there are personality traits and abilities associated with the fulfilment of the entrepreneurial function, typically involving intelligence, judgement, foresight, and creativity; whilst not defining the entrepreneur in a strict sense, they do constitute part of the image of what it might mean to 'be entrepreneurial'. Accordingly, it then becomes necessary to consider how these abilities arise in certain people, the time it takes for these abilities to develop and, perhaps most importantly in the context of this thesis, how people with such abilities are distributed across space. For instance, it can be suggested that there exists a heterogeneous spatial distribution of people with the requisite 'intelligence, judgement, foresight, and creativity' to behave entrepreneurially and that some regions might have a greater density of people with these 'entrepreneurial traits'. The reasons why the spatial distribution of people with these 'entrepreneurial traits' is heterogeneous is discussed extensively in Chapter 4 Section 4.5, which looks to examine contemporary human capital approaches to entrepreneurship and the work of Theodore Schultz (1975; 1980) in particular. This research suggests that the spatial distribution of people with 'entrepreneurial ability' is a significant determinant of the spatial variations observed in entrepreneurship and this line of reasoning forms an integral component of the empirical analysis in the later chapters of this thesis. It can be seen that the beginnings of this aspect of entrepreneurial theory can be found in the earliest approaches to entrepreneurship in the economics literature.

Finally, An emphasis on decision making under uncertainty may explain why the assumptions of the neoclassical approach, and in particular general equilibrium analysis, marginalised entrepreneurship as a field of mainstream economic enquiry; the homogenisation of agents and their conceptions of human behaviour divorces uncertainty from the decision making process. Baumol (1993) suggests that the general equilibrium model serves purely as an "instrument of optimality analysis of well-defined problems which need no entrepreneur for their solution"; instead, he is replaced by the 'passive calculator', who "performs a calculation that yields optimal values for all of its decision variables…. [constituting] the profit maximising business decision" (van Praag, 1999). There is clearly no uncertainty involved in this form of decision making process. Thus, the role of entrepreneurship is related to the philosophical core of economic methodology, where there appears to be a trade-off between the descriptive empirical realism of the classical approach and the logical coherence in the abstractions of the neoclassical approach; entrepreneurship has a greater role in the former. Alfred Marshall's approach provides an attractive medium between realism and logical coherence where entrepreneurial decision making has a role. Marshall rescues the entrepreneur from potential obscurity by applying this method of analysis with certain caveats regarding time, price variability, and the 'unreal' possibility of attaining equilibrium; this allows uncertainty back into the models and with it the entrepreneur.

3

Chapter 3 – Economics in the Twentieth Century – Entrepreneurship in Rival Schools of Thought

3.1 – Introduction

There was a substantial change in the methodological approach and content of economic theory in the latter parts of the nineteenth century. During this period, from Jevons and Walras through to Marshall, “marginal utility analysis became the accepted basis of economic theory [and] what follows is almost entirely a process of refinement” (Roll, 1992: 361). By the first decades of the twentieth century, the principles of the neoclassical system of Alfred Marshall were firmly in place and “in what would one day be called microeconomics, the subject matter in direct descent from the classical system, far more would be the same than would be changed” (Galbraith, 1987: 112).

Despite the development of an established economic orthodoxy in the form of the Neoclassical School, various ‘currents of thought’ and ‘national schools’ were often found in “bitter conflict among themselves [that] should not be undervalued” (Screpanti and Zamagni, 1995: 177). These ‘currents of thought’ often questioned some of the key tenets of the Neoclassical School, particularly with regards to its methodological approach. The purpose of this chapter is to discuss three of the more prominent alternative ‘currents of thought’ and how they conceptualise entrepreneurial behaviour. Section 3.2 will analyse the dynamic, evolutionary system of Joseph Schumpeter and the ‘Creative Destruction’ of the entrepreneur within this system. Section 3.3 analyses the philosophical contributions of Frank Knight, in what became the foundation of the Chicago School of thought. Section 3.4 discusses the Austrian School of thought and the key role attributed to entrepreneurship in its theory of competitive markets. Section 3.5 will conclude, highlighting the key contributions of these three alternative approaches and any common themes that can be identified.

3.2 – Joseph Schumpeter

Joseph Schumpeter (1883-1950) is widely regarded as one of the most prominent economists of the 20th century and provided an 'influential amendment' to the Marshallian system (Galbraith, 1987: 181). Schumpeter's approach combined elements of neoclassical economics, the Historical School, and Marxist criticism into his theory of economic dynamism and development (Andersen, 2012). He considered Walrasian general equilibrium as "the greatest achievement of nineteenth-century economic science"; however, he believed there were serious shortcomings in the Walrasian approach, describing it as "logically coherent but incapable of accounting for the really important phenomena such as change, growth, technical progress, or profit" (Screpanti and Zamagni, 1995: 243). He shares an affinity with the classical economists by taking the capitalist system as a foundation and concerning himself with the "probable path of growth in reality rather than to construct abstract models" (Roll, 1992: 542). Parallels with Marx are seen in that Schumpeter defined capitalism from a historical perspective and emphasised the role of technological change, although Schumpeter defined innovation more widely and also attempted to study the structural transformation of capitalism over time in an evolutionary way (Roll, 1992 541-542; Screpanti and Zamagni, 1995: 243). What emerges from this diverse mix of economic influences is a comprehensive dynamic theory of capitalism, expressed in his *The Theory of Economic Development* (1911), where entrepreneurship plays a central role.

In order to discuss Schumpeter's view of entrepreneurial behaviour, the economic environment in which he saw the entrepreneur operate must be considered. Schumpeter viewed capitalism as a continuous, dynamic process that is constantly subject to endogenous change:

"The essential point to grasp is that in dealing with capitalism we are dealing with an evolutionary process.... Capitalism is by nature a form or method of economic change and not only never is but never can be stationary." (Schumpeter, 1976: 82)

Evolutionary processes were the fundamental basis of capitalism, a self-fulfilling consequence of its own ability and requirement to mutate and evolve. Schumpeter cites several examples of this dynamic process, describing the 'revolutions' within various industries that cause economic progress; these range from technical revolutions such as agricultural mechanisation to the "organisational development from the craft shop to the factory" in manufacturing. Furthermore:

"[It is this] process of industrial mutation.... that incessantly revolutionises the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in." (Schumpeter, 1976: 83, original emphasis)

Thus, the capitalist economy is in a perpetual dynamic process of evolution, where 'Creative Destruction' is the force of endogenous change. The prevalent static analysis of 'ordinary economic theory' is incapable of explaining these dynamic revolutions or the reasons for them (Swedberg, 2007). Creative Destruction is a manifestation of developmental human behaviour within the economic system, resulting in "such changes in economic life that are not forced upon it from without but arise by its own initiative from within" (Schumpeter 1911, cited in Swedberg, 2007). This is to be contrasted with adaptive human behaviour within the economic system, described by Schumpeter as bringing about "economic changes that are not qualitatively new", emerging as a response to exogenous forces. Adaptations are the 'norm' amongst the "peasants and artisans" who are the feature of static equilibrium theory, as they respond within given limits and are not interested in 'doing anything radically new' (Swedberg, 2007). Herein lays an important distinction between Schumpeter's conception of economic behaviour and the static equilibrium theories expounded by neoclassical Walrasian general equilibrium theory. Schumpeter defines types of human behaviour within a capitalist system that go beyond the adaptive, utility maximising behaviour of a homogenous group of consumers partaking in mutually beneficial exchange. The distinction between developmental and adaptive behaviour is important in Schumpeter's dynamic economic theory and it is developmental human behaviour that is integral to the Schumpeterian Entrepreneur.

Schumpeter asserts that in order for development to occur, leaders must emerge to overcome the obstacles that cause a static environment, namely the resistance exhibited by society towards change (Swedberg, 2007); this leader is a "Man of Action", someone full of energy who doesn't accept reality as it is and seeks to change it. The entrepreneur is the economic 'Man of Action' and they fulfil this role through implementing 'new combinations', defined by Swedberg (2007) as "new ways of using existing means or factors of production". This is similar to Say's approach, which emphasises combining resources and factors differently in order to produce goods for profit as the basis for entrepreneurship; this is recognised by Schumpeter himself, although he declares that Say does not develop the idea as fully as he should (Swedberg, 2007).

Schumpeter specifically identifies five types of 'new combinations' through which the entrepreneur encourages economic development. These are described by Hagedoorn (1996) as the introduction of "a new product or a new quality of product; a new method of production; a new market; a new source of supply of raw materials or half manufactured goods; and implementing the new organisation of any industry." Swedberg (2007) suggests that these 'new combinations' represent, in a quite systematic way, the production of a good from beginning to end, its release onto the market, and the organisation of this market. The essence of Schumpeterian entrepreneurship then becomes the varying of some element of this process for the better. These creations are the principal 'endogenous cause of economic change', destroying the static equilibrium of the economy to create conditions for a new equilibrium to be attained. The implication of this is that persistent innovation implies permanent change and permanent disequilibrium (van Praag, 1999); hence the 'stationary' equilibrium conditions of the Walrasian models are unlikely in reality.

The Walrasian equilibrium conditions are described by Schumpeter as a 'circular flow' of mutually beneficial exchanges between individual economic agents that allows the system to replicate itself through time (Screpanti and Zamagni, 1995: 243). Disrupting this 'circular flow' through entrepreneurial behaviour can 'develop' the system to a new state. Parallels can be seen with Marshall, however the key difference between them regards why the Walrasian equilibrium would never be reached. For Marshall, market forces always tended towards equilibrium as individuals within the market were incentivised to behave in a manner that encouraged this process. For Schumpeter, entrepreneurial behaviour on behalf of some agents, which is a 'fundamental aspect' of capitalism, completely destroys any equilibrium tendencies within the market and these endogenous factors caused persistent disequilibrium within markets. That the capitalist economy's ultimate destiny is permanent, endogenously caused disequilibrium as a consequence of innovation demonstrates Schumpeter's separation from mainstream neoclassical economists, who postulate that markets must have an equilibrium tendency.

In terms of characterising entrepreneurial behaviour specifically, parallels can be drawn with Say when considering Schumpeter's analysis of the entrepreneur as a higher order of labour and a factor of production. For example, Hagedoorn (1996) suggests "labour is differentiated by its direction", with creative labour being of a higher level than directed labour; however, Hébert and Link (1989) argue that doing this could perhaps detract from the uniqueness of the entrepreneurial function. Schumpeter significantly underplays the significance of the risk involved with entrepreneurial activity, which is central to the theories of Say and Cantillon. The Schumpeterian entrepreneur is neither a risk-bearer nor the supplier of capital, these roles are attributed to the banker or capitalist (van Praag, 1999) and as such, the entrepreneur is the 'typical debtor of the capitalist society' (Hagedoorn 1996). The entrepreneurial function should therefore not be defined by risk taking, rather it is characterised by the proactive behaviour of the entrepreneur, who is "not necessarily a strictly rational economically maximising agent" (Hagedoorn 1996: 890). Furthermore, the Schumpeterian entrepreneur does not face the same inner obstacles of the 'static man' and has 'other sorts of motivation'. Van Praag (1999) describes the factors that motivate Schumpeterian entrepreneurs by as including the desire to achieve social distinction, the desire to succeed, to prove superiority, and the joy of creation and changing; these are the rare inherent psychological characteristics of the Schumpeterian entrepreneur. These aspects of the Schumpeterian entrepreneur are particularly interesting as they suggest incentives for and returns to entrepreneurship other than financial profit. This is reiterated further by van Praag (1999) who suggests that Schumpeterian "entrepreneurs do not perform their task…. in order to satisfy their own consumption wants." Moreover, Schumpeter conceptualised profit differently from the earlier classical authors; whilst technically still a surplus of revenues over cost, Schumpeter defined profit as a form of temporary monopoly rent accrued by virtue of the entrepreneur introducing a 'new combination' before competitors. Eventually, the processes of competition would diffuse the new innovative practice amongst competitors, eroding the entrepreneur's differential earnings (Screpanti and Zamagni, 1995: 244). The market would then approach a new stationary state, only to be broken once again by the creative destruction of entrepreneurial behaviour and set on a new path. Monetary profit is seen less as an incentive and more as a residual to entrepreneurial activity in the Schumpeterian system. The consequence of this Schumpeterian approach is that dis-equilibrating entrepreneurial behaviour will always be present in the capitalist economy, as it depends on the stable characteristics and intrinsic motivations of a unique group of Schumpeterian entrepreneurs, as opposed to the risks surrounding the outcomes of certain decisions. Here, monetary profit and decision making under uncertainty takes on much less relevance than is seen in other entrepreneurial theories; in this regard, it becomes clear as to why Schumpeter believed that risk was not the defining feature of entrepreneurship (Hagedoorn, 1996). Of course, risk and uncertainty might still be present in the actions of the Schumpeterian entrepreneur, but they no longer act to separate who will behave entrepreneurially and who will not; this is instead determined by a unique set of cognitive attributes and desires.

Thus, Schumpeter emphasised a key role for entrepreneurship in economic development, creating a conception of the entrepreneur as a colourful, ambitious individual who harbours the traits necessary to create and innovate. In doing so, they destroy static conditions and set the economy on a new path; this is the true, dynamic, ever-changing nature of capitalism and development. Schumpeter's theory of capitalism and entrepreneurship has been very influential and Galbraith (1987: 181) indicates:

> "The entrepreneur did – and still does – much for economics. He glows in the sombre company of labourers, white-collar workers, solemn executives and assorted corporate bureaucrats. Unlike the capitalist, the entrepreneur carries no burden of Marxian guilt. His distinction, which continues with no slight nimbus to the present day, is a major legacy of Schumpeter."

3.3 – Frank Knight and the Chicago School

Frank Knight's (1885-1972) doctoral dissertation, *Risk, Uncertainty and Profit* ([1921] 2006), contains his major contributions to entrepreneurial theory, and paved the way for several important developments in economics, including decision theory and theories of imperfect competition (Emmett, 1999). The work centres on concepts of risk and uncertainty, "envisaged from the immediate standpoint of the problem of profit in distributive theory" (Knight, 2006: 18). His description of profit as a 'problem' in distributive theory is a reflection of the lack of realism exhibited by the abstract economic models of neoclassical theory. Walrasian general equilibrium theory has the "primary attribute of... the 'tendency' to eliminate profit or loss, and bring the value of economic goods to equality with their cost" (Knight, 2006: 18); however, "in actual society, cost and value only 'tend' to equality;... they are usually separated by a margin of 'profit' positive or negative", such that an adequate theory of profit is required (Knight, 2006: 19). Thus, Knight's (2006) work goes to the heart of the debate of economic methodology, namely the relationship between the deductive abstractions perhaps best typified by Walrasian general equilibrium and their applicability to real world phenomena. In fact, much of the first chapter of RUP is dedicated to the concerns of economic methodology and scientific methodology in general. In addressing these concerns and developing a 'satisfactory' theory of profit, Knight (2006) invokes what he considers as key differences between the concepts of risk and uncertainty, how they differ, and their relationship to real economic phenomena. Naturally, the role of the entrepreneur becomes involved in Knight's (2006) treatment of risk, uncertainty, and profit, which follows from preceding literature in that it emphasises the relationship between entrepreneurship and profit, as well as the need for realism in economic theory.

According to Knight (2006: 19-20), "the familiar notion of risk… as loosely used in everyday speech and in economic discussion, really covers two things which, functionally at least… are categorically different." The significant difference between risk 'proper' and uncertainty is that risk concerns probabilities that are calculable, whereas uncertainty involves probabilities of which there is no valid basis for calculation due to the uniqueness of the event in question (Knight, 2006); risk "is so far removed from an unmeasurable [uncertainty] that it is not in fact an uncertainty at all" (Knight, 2006: 20). This concept has important implications for economic theory, namely in that:

> "the difference between the 'perfect competition' of theory and the remote approach to it which is made by the actual competition of… twentieth century United States is the absence in the first case and the presence in the second case of uncertainty, properly defined." (Mitchell, *et al.*, 1922)

Furthermore, "along with the characteristics which differentiate the world of pure theory from the world of experience, uncertainty supplies explanations of interest and profit" (Mitchell, *et al.*, 1922); thus, profit can only exist in an uncertain world and not necessarily in a risky one. For example, Bewley (2001) suggests that if new enterprises involved risks that can be evaluated, then markets would be organised for contingent claims on that risk and the entrepreneur could market the risk so as to not bear it themselves. This is illustrated by Brouwer (2002), using the example of Microsoft's success in the 1990s: "if everyone had known beforehand that Microsoft would become the most successful company of the 1990s investors would have rushed to provide funding… As a consequence Bill Gates could have obtained all the money he wanted at risk-free rates of interest." Generally, if there was a perceivable and measurable risk involved with an enterprise, rates of return would adjust to leave no profit for investors on average. In reality, Bill Gates was funded by venture capital firms that took equity shares in Microsoft, who were eventually 'handsomely' rewarded for the company's success. The nature of uncertainty ensures that markets cannot be organised for entrepreneurial services via the price mechanism (Dew, Velamuri and Venkataraman, 2004).

Knight considered the importance of uncertainty to go much further than defining the basis for private enterprise where the motive force is profit; it has much deeper ethical, practical, and philosophical significance (Gordon, 1974). It is a basic characteristic of human existence, as "a world lacking in uncertainty [but not necessarily risk] would not be one of free human beings at all, but of determined automata." A world without uncertainty would become one where no meaning could be attached to concepts such as 'valuing' and 'deciding', such that "consciousness itself would be redundant" (Gordon, 1974), leaving nothing to be decided by acts of will. Uncertainty is needed in order for our surroundings to be:

> "modified by the values man adopts and the choices he makes, and it is man's capacity to change the world, and himself, that is the most essential quality, and opportunity, of the human condition... Thus, man is free and thinking because of uncertainty" (Gordon 1974: 572).

It is clear that Knight places a great significance on the importance of uncertainty; the entrepreneur is perhaps the economic expression of an uncertain world and thus the bearing of economic uncertainty is considered to be the role attributed to the entrepreneur. Van Praag (1999) cites this as an extension of Cantillon's theory. However, uncertainty as defined by Knight is further developed and has a deeper philosophical significance, whilst the entrepreneurial function is also not explicitly defined in the form of specific behaviour such as arbitrage. Bewley (2001) suggests the role of the Knightian entrepreneur is to initiate uncertain investment decisions, without defining precisely what such investments they might involve. This is indicative of the wider philosophical context that Knight is concerned with, as Emmett (1999: 44-45) points out that the entrepreneurial function "is by definition (for Knight) not subject for analysis."

Some of the interpretations of Knight's approach (e.g. Emmett, 1999; van Praag, 1999; Bewley, 2001) entail aspects of entrepreneurship that are closer to what might be expected from entrepreneurship in modern day parlance; namely, that entrepreneurship entails the creation of a firm/organisation to initiate uncertain investment decisions for profit. Van Praag (1999) emphasises the profit incentive in Knightian entrepreneurship and this is unsurprising given that Knight considered uncertainty to be the reason for the existence of profit. Within the context of the firm, the entrepreneur assumes the responsibility for direction and control of productive resources when there is uncertainty involved in the decision process (van Praag, 1999). This perspective has implications for the large firm where uncertain business decisions are made by several decision-makers within the organisation. Therefore, superficially, van Praag's (1999) broad interpretation would imply that all managers within the firm who direct and control resources with uncertain outcomes can be considered to be behaving entrepreneurially. To some extent this is affirmed by Emmett (1999: 44), who suggests that "entrepreneurial success inevitably leads to the creation of a production process large enough to require supervision beyond that which the entrepreneur can provide." This results in the establishment of an organisation that is "fractured by the principal-agent problem", the success of which is dependent on the responsible direction of the organisation by the organisation creating entrepreneur, who applies "critical judgement.... regarding the capacities and character of potential managers" (Emmett, 1999).

Thus, Knightian entrepreneurship has similar features to both Say and Marshall, who both highlight leadership and the management of resources within a firm/organisation as a key aspect of entrepreneurship; naturally, it follows that there are several personality characteristics that are required for successful entrepreneurship. These include superior judgment, which is exercised on the abilities and personal qualities of others who the entrepreneur must deal with (competitors, suppliers, buyers and employees) and, most importantly, on an estimation of the value of an uncertain outcome (van Praag, 1999). In addition to judgement, "a disposition to act on one's own opinion, a venturesome nature and foresight" (van Praag, 1999) are considered as requisite skills. Highlighting the traits necessary to successfully partake in entrepreneurial activity is also common in contemporary psychological and human capital approaches to entrepreneurship.

Bewley's (2001) interpretation of Knightian uncertainty also provides insights into a dynamic and innovative entrepreneurial process that is reminiscent of Schumpeter:

> "The knowledge created by one innovation reduces the uncertainty associated with other possible innovations and so makes them more attractive to investors. The knowledge also focuses subjective probabilities on those innovations which are more likely to succeed and so tends to stimulate them" (Bewley, 2001: 39)

Accordingly there are two types of knowledge associated with innovation: knowledge of new concepts/ideas and knowledge relating to 'experimental verification'. The former relates directly to the 'Knightian entrepreneur', someone who has low levels of 'uncertainty aversion' and can establish subjective probabilities that are favourable to the decision to conduct an enterprise to appropriate the returns from an innovative activity. The latter relates to how successful entrepreneurship in a particular field leads to a reduction in uncertainty surrounding the prospects of related enterprise and encourages further participation in similar entrepreneurial activity by other individuals (Bewley, 2001). Bewley (2001) continues to suggest several implications for innovative activity as a result of these two aspects, within the context of the 'Knightian model of entrepreneurship'. Regarding new ideas, innovation is more likely to occur if the opportunity to innovate is dispersed among many individuals instead of concentrated in the hands of a few, as this increases the probability that this may incorporate an 'unusual individual' with a low uncertainty aversion. Furthermore, enterprise is less likely to occur if the decision to innovate has to be agreed by every member of a group of investors, as the subjective probabilities of each group member will differ on whether the enterprise is likely to be profitable. Large corporations where the decision making process is dispersed are more likely to be conservative in the innovative process than individuals acting independently. Bewley (2001) links this with the literature on shareholder control, citing it as an example of how "any kind of cooperation by a group can lead to a strong form of collective uncertainty aversion". This second point is particularly relevant to the Knowledge Spillover Theory of Entrepreneurship (KSTE) (Acs*, et al.*, 2009), illustrating the mechanisms through which, in light of the uncertainty that characterises new knowledge (Arrow, 1962b), incumbent organisations will be conservative in their innovative activity, discussed in detail later.

Regarding knowledge from 'experimental verification', the low uncertainty aversion required for Knightian entrepreneurship suggests that the reduction of uncertainty resulting from past innovative entrepreneurship will create knowledge that will encourage further entrepreneurship:

> "The Knightian description also makes it possible to visualize a world in which waves of innovation occur in a natural way. Entrepreneurship, through innovation, creates knowledge. This knowledge in turn reduces the uncertainty about the prospects of other possible innovations. Since uncertainty inhibits innovation, reducing uncertainty tends to stimulate new innovations, which, whether successful or not, create new knowledge, and the process can feed on itself indefinitely" (Bewley, 2001)

The dynamic nature of this process is reminiscent of the dynamism within Schumpeter's theory of 'creative destruction', where persistent innovation through entrepreneurship endogenously creates opportunities for further innovative entrepreneurship. Furthermore, knowledge of previous innovation that reveals the feasibility of further potential innovation and the propensity of this knowledge to disperse across the population are likely to be key determinants of entrepreneurial activity within the economy. The dispersion of knowledge incorporates a spatial context when considering how physical distance from areas where entrepreneurial activity occurs affects how the knowledge of feasible entrepreneurial activity diffuses. Döring and Schnellenbach (2006) argue there is a "widespread consensus that spatially confined knowledge spillovers are an important empirical phenomenon" and that the diffusion of knowledge over space is costly. Importantly, however, "no consensus is reached about the spatial range that can be attributed to knowledge spillovers, and in fact the majority of studies refuse to quantify a range at all" (Döring and Schnellenbach, 2006: 384). The costly diffusion of knowledge over space clearly implies that proximity matters, such that knowledge of successful innovative entrepreneurship diffuses outwards from the core region, where the innovative entrepreneurship occurs, to periphery regions. This process implies a form of spatial dependence, whereby entrepreneurship will encourage further imitative entrepreneurship in neighbouring regions. However, this is not the only spatial effect that might exist concerning regional entrepreneurship, knowledge, and Knightian uncertainty. For example, one of the fundamental mechanisms thorough which knowledge spills over and disperses is by communication through professional and social networks: "configurations of firms and research institutions or of cooperating small businesses may advance the use of knowledge as a shared resource... [and] it appears to be evident that geographical proximity does matter for these firms" (Döring and Schnellenbach, 2006: 387). Although the knowledge Döring and Schnellenbach (2006) refer to concerns knowledge from research activities and not knowledge of entrepreneurial activity *per se*, it serves to illustrate that proximate local networks can encourage the spread of knowledge. The important thing to note here is that regions and industrial clusters are home to vastly different networks, such that knowledge of feasible entrepreneurial activity might spread through network communication differently in some regions than in others, a process implying the presence of spatial heterogeneity.

Knight's (2006) thesis, and subsequently Bewley's (2001) interpretation of it, is the first approach to entrepreneurship discussed here that emphasises the role of knowledge and how it influences the uncertainty of entrepreneurial opportunities, two major themes of this thesis. Associated theories, namely the KSTE and the concept of entrepreneurial ability discussed in Chapter 4 Sections 4.4 and 4.5, provide the theoretical basis for the econometric analysis to come and they find some early foundation in Knight's (2006) work. Furthermore, the potential presence of both spatial dependence and spatial heterogeneity concerning knowledge and the uncertainty of entrepreneurial opportunities from a spatial perspective has important implications for econometric analyses using spatial data in this context; this is a major focus of this thesis and accordingly these issues will be discussed in greater detail in Chapter 5.

In summary, Knight develops a philosophy in which uncertainty plays a central role, defining this uncertainty differently from risk; when faced with risk, probabilities related to possible outcomes are calculable in some sense, whereas there is no basis for such calculations when faced with 'true' uncertainty. It is this uncertainty that makes man truly free and it is pervasive throughout reality. The Knightian entrepreneur is an expression of economic uncertainty, whose purpose is to initiate uncertain investment opportunities for profit. In order to be successful, the entrepreneur exercises superior judgement, foresight, and intelligence (van Praag, 1999). The importance of Knight's (2006) work should not be underestimated, and it is described by Emmett (1999: 30) as an "important precursor to several of the most important twentieth-century developments in economics."

3.4 – Von Mises, Hayek, Kirzner, and the Austrian School

The Austrian economic tradition arguably takes the entrepreneur much more seriously (Casson, 2003) and employs a different methodological and philosophical approach to the neoclassical tradition. In order to discuss the entrepreneur within a contemporary Austrian context, these differences need to be addressed. Carl Menger (1840-1921), one part of the 'celebrated trinity' discussed in Chapter 2 Section 2.4, is widely regarded as the founder of the Austrian School of thought, reconstructing the foundations of economic science in his *Principles of Economics* (1871) (Screpanti and Zamagni, 1995: 170). From these foundations and the theoretical developments of Ludwig von Mises (1881-1972) and Friedrich Hayek (1899-1992), a view of entrepreneurship that is distinctly Austrian has been assembled by Israel Kirzner (1973; 1997).

Whilst being an instigator of the 'Marginalist Revolution', Menger had two main methodological concerns with the approaches of the classical schools of thought, and by extension the Neoclassical School as it developed (Screpanti and Zamagni, 1995; Hunt, 1979). First, Menger believed that in order for economics to be considered a 'pure science', it had to be *wertfrei:* 'value free' (Screpanti and Zamagni, 1995: 172). The ethical orientations of political economy were "a vague postulate devoid of any deeper meaning in respect of both the theoretical and the practical problems of the latter” (Hunt, 1979: 250). In this regard, he opposed the application of utilitarian principles in the classical and neoclassical approaches as such ethical positions had no place in a truly scientific theory. Second, Menger believed that economics could only deal scientifically with individual units, such as households and firms, and that a scientific theory of social aggregates would not be possible (Hunt, 1979: 251), insisting that an “atomistic approach is a methodological necessity” (Roll, 1992: 353). A subjective theory of value that incorporated marginal utility concepts naturally engendered a form of methodological individualism that was fundamentally opposed to the methodological holism championed by the historical, classical, and Marxist economists. Also, Menger perceived logical and technical difficulties caused by the incompatibles between methodological individualism and policies based on utilitarian principles, namely those that sought to promote ‘the greatest welfare for the greatest number’ (Screpanti and Zamagni, 1995: 173). Therefore, the retention of utilitarian principles by proponents of the Neoclassical School that retained an air of methodological holism was a major methodological concern for Menger; for example, the policy of promoting competition on the basis of a maximisation of social welfare, a tenet of neoclassicism, was considered incompatible with the methodological individualism required by a subjective theory of value.

Menger’s departure from the Classical, Neoclassical, Marxist, and Historical Schools led to the creation of a school of thought that staunchly adhered to ‘subjectivism’ (Langlois, 1985), which Casson (2003) describes as ‘extreme’. This doctrine seeks to explain phenomena in social science by “tracing social phenomena back to the perceptions and intentions of the agents whose actions those phenomena comprise” which, when taken ‘seriously’, “immediately forces one to ask about the motives and – more to the point – the knowledge the economic agent possesses” (Langlois, 1985: 311). Furthermore, Menger was more interested in the concepts of uncertainty, imperfect information, and the ‘open-endedness’ of the world (Langlois, 1985). The later contributions of both von Mises and Hayek directed the Austrian tradition away from the course being taken by neoclassical theorists at the time, and by 1950 both theorists had “crystallised definitive statements of their disagreements with mainstream economics” (Kirzner, 1997).

The discontent with the neoclassical approach that characterises later Austrian theory is based on two key criticisms; namely the lack of realism and the methodologically legitimate demand to expect a theory of the market to incorporate how equilibrative tendencies are ‘set into motion’ (Kirzner, 1997). Austrians are said to take ‘sharp exception’ to the way in which individual decision making is reduced to a “mechanical exercise in constrained maximisation” (Kirzner, 1997); this would only be possible if human choice was treated as if it were not made in an ‘open-ended’ fashion and would imply that the number of decisions available to an agent are finite, which would “denature human choice entirely” (Kirzner, 1997). Regarding the equilibrative tendencies of market participants, Austrians believe that they are entitled to a “theoretical basis for the claim that equilibrating processes systematically mould variables in a direction consistent with the conditions postulated in the equilibrium models”; that is, we are entitled to a ‘story’ of how equilibrium is reached (Kirzner, 1997) and these qualms are addressed differently by von Mises and Hayek.

Von Mises viewed the market as an entrepreneurially driven process, driven by speculative, profit seeking actions, as opposed to the coordination of actions between consumers or between the owners of capital. These speculative activities are said to be the ‘element’ that would bring about the ‘unrealisable state of the evenly rotating economy, a state that approximates a general state of market equilibrium. Von Mises describes the mathematical techniques used to describe equilibrium states as ‘mere play’, stating that the “problem is the analysis of the market process” and not necessarily the conditions characterising an equilibrium solution (von Mises, 1949, cited in Kirzner, 1997).

Hayek’s theoretical emphasis was on the role of knowledge within the market and the dispersion of this economic knowledge across the agents comprising the market. In a seminal piece discussing the role of knowledge in society, Hayek (1945) identifies two types of knowledge in society; scientific, or technical, knowledge and the ‘knowledge of the particular circumstances of time and place'. This latter knowledge reveals itself in many ways: the manager who is aware of a surplus stock to be called upon when there is an interruption in supply, an estate agent whose knowledge comprises primarily of temporary opportunities, and the arbitrageur capitalising on differences in local commodity prices are all manifestations of this knowledge. Despite this form of knowledge being "generally regarded with a kind of contempt", Hayek (1945: 522) considers it an important facet of society; adapting to rapid changes in the particular circumstances of time and place forms the main economic problem. The key concept behind this knowledge, and also arguably scientific knowledge, is that it is dispersed across time and space. A form of decentralisation utilising the price mechanism to coordinate actions is needed to solve this problem:

> "In a system where the knowledge of the relevant facts is dispersed among many people, prices can act to coordinate the separate actions of different people in the same way as subjective values help the individual to coordinate the parts of his plan" (Hayek, 1945: 526).

Thus, the price mechanism becomes a way of communicating information across market participants and market participation becomes a discovery process. This is in contrast with the neoclassical conception of the price mechanism, the process resulting in the market price at which supply and demand are equalised and the market is cleared. Hayek's view of the equilibrating process is "one during which market participants acquire better mutual information concerning the plans being made by fellow market participants" (Kirzner, 1997). When considered with von Mises' thesis that the market process is driven by the speculative action of entrepreneurs seeking opportunities for profit in conditions of disequilibrium, two separate, key features of the Austrian entrepreneur are identified. According to Kirzner (1973; 1997) it is the similar views of competition harboured by von Mises and Hayek that unites their theories.

Competition within the neoclassical paradigm presents somewhat of a paradox. The conditions of perfect competition are a state in which all firms are price takers with perfectly elastic demand curves; furthermore, it is assumed that the goods sold in these perfectly competitive markets are both homogenous and perfect substitutes. These markets are characterised by firms operating in an environment in which all traces of rivalry or actual business competition are absent (Kirzner, 1997). However, this neoclassical theory of 'uncompetitive' competitive markets is not an accurate representation of the real nature of markets, as "on the market every commodity competes with all other commodities" (von Mises, 1949, cited in Kirzner, 1997). Competition "manifests itself in the fact that the sellers must outdo one another by offering better goods and services and that buyers must outdo one another through offering higher prices" (von Mises, 1949, cited in Kirzner, 1997), a 'dynamic rivalry' excluded from neoclassical analysis. Von Mises' rejection of neoclassical competition is based on the processes of speculative entrepreneurs who are constantly trying to outdo each other through price bargaining and product differentiation. The speculative aspect is particularly important as it suggests that human choice is based on conjecture with the possibility of error, as opposed to being rational and optimising. Hayek's criticism of neoclassical competition centres on the role of knowledge, as he conceptualises the market as a discovery process in which participants acquire better mutual knowledge through interaction, causing persistent changes. The neoclassical equilibrium is said to be a state where the "data for all of the individuals are fully adjusted to each other", however the economic problem that "requires explanation is the nature of the process by which the data are thus adjusted" (Hayek, 1948, cited in Kirzner, 1997). The 'dynamic process of competition' is "a process of the formation of opinion… a process which involves a continuous change in the data" (Hayek, 1948, cited in Kirzner, 1997), the significance of which must be missed by "any theory which treats these data as constant" (Hayek, 1948, cited in Kirzner, 1997). To both von Mises and Hayek, the concept of competition must focus on the equilibrating process itself, as opposed to the state of the market at the end of that process (Kirzner, 1997). Both argue that neoclassical theory fails to offer a realistic and satisfying theoretical framework with which to analyse market economies. It is from these fundamental arguments, 'central' to modern Austrian economic theory, which Kirzner (1973; 1997) develops a theory of 'entrepreneurial discovery'. Three main features of this are identified: (1) the entrepreneurial role; (2) the role of discovery; (3) rivalrous competition.

Kirzner (1973; 1997) defines the Austrian entrepreneur in a similar manner to his historical predecessors, highlighting the various relevant elements of von Mises' and Hayek's work. According to Kirzner (1997), von Mises regarded the entrepreneur as an "acting man in regard to changes occurring in the data of the market", viewing entrepreneurship as "human action seen from every aspect of the uncertainty inherent in every action" (von Mises, 1949, cited in Kirzner, 1997). The broadness of the entrepreneurial definition, "where every actor in real and living economy is always an entrepreneur" was a tradition continued by Schultz. However, it is unclear whether Schultz (1975; 1980) was significantly influenced by the theoretical writings of von Mises (1949) or Hayek (1948), instead developing his entrepreneurial theory from an empirical basis regarding human capital and what he deemed as entrepreneurial. Furthermore, there is an emphasis on 'uncertainty' in entrepreneurial action, which clearly relates to the insights of Knight (1921) and his contribution to individual decision making. Austrian theory recognises the speculative element in all individual decision making, the nature of which diverges sharply from the neoclassical perspective (Kirzner, 1997). Neoclassical decision making is made within a known framework with given objective functions, resource constraints, and technology; here, uncertainty expresses itself in known probability distributions. This renders boldness, imagination, and drive irrelevant and is incompatible with the Austrian conception of entrepreneurship (Kirzner, 1997).

The distinction between Austrian uncertainty and neoclassical uncertainty appears to be a continuation of the distinction between 'Knightian' uncertainty and 'Knightian' risk. Austrian perspectives on uncertain human action and entrepreneurial decision making imply an "open-ended framework within which all decisions made must necessarily partake of the speculative character essential to the notion of entrepreneurship" (Kirzner, 1997), an inference analogous to 'Knightian' uncertainty and his concept of the entrepreneur. Thus, both the Chicago and Austrian approaches share a broad view of the entrepreneurial function. The open ended nature of the world in Austrian theory implies that uncertainty is present in all decision making, and on that basis all decision making is entrepreneurial in some regard.

Kirzner (1997) states that the Austrian entrepreneur seeks to change price/output data through action, instead of acting within given price/output data, driving a dynamic market process that is reminiscent of the Schumpeterian approach. Such parallels are expected given Schumpeter's Austrian nationality and the fact that he is typically considered as part of the 'second generation' of Austrian economists with von Mises (Langlois, 1985: 322). Although Schumpeter emphasised 'creative destruction' through the introduction of 'new combinations' to create changes in the market, Kirzner's (1997) approach is different. Each market is characterised by opportunities for pure entrepreneurial profit, created by earlier entrepreneurial errors which resulted in shortages, surplus or misallocation. These 'errors' are caused by the misjudged actions of entrepreneurs, a manifestation of the uncertainty in entrepreneurial decision making and the fallibility of human action that characterises an open ended world. Through arbitrage, 'daring and alert' entrepreneurs can attempt to procure profit through the discovery of these errors, "buying where prices are 'too low' and selling where prices are 'too high'", such that "shortages are filled and surpluses are whittled away" (Kirzner, 1997). The exploitation of these profit opportunities move the market towards equilibrium; hence entrepreneurs in Kirzner's (1973; 1997) theory are the "equilibrating force in the market" (van Praag, 1999). This is in contrast to Schumpeter's disequilibrium causing entrepreneurs, highlighting the fundamental difference. Furthermore, Kirzner's (1973; 1997) entrepreneurial process cannot guarantee equilibrium in a dynamic world due to the possibility of entrepreneurial error, but profit incentives tend to "nudge the market in this direction" (Kirzner, 1997).

It is plausible to suggest that Kirzner's (1973; 1997) entrepreneurial theory is an extension of Cantillon's theory of the entrepreneur as a profit seeking arbitrageur (van Praag, 1999). However, van Praag's (1999) exposition of Kirzner's (1973) entrepreneurial theory perhaps over emphasises the role of recognising and exploiting profit opportunities in explaining Kirzner's (1973) definition of the entrepreneurial function. Whilst this is undoubtedly a key aspect, it should not be forgotten that there is a significant and intricate philosophical background to Kirzner's contemporary Austrian entrepreneur, borne out of the work of von Mises (1949) and Hayek (1948). This entrepreneur is the manifestation of individuals acting and making decisions in an 'open-ended' world, where there is a 'speculative element in all decision making' (Kirzner, 1997). The rejection of basic principles of neoclassical microeconomic theory in this regard, which the contemporary Austrian entrepreneur represents, should also not be understated.

The role of entrepreneurship in creating and dispersing knowledge can be attributed to Hayek's assertion that the market process is a "process of mutual discovery", where market participants become better informed of one another's plans and actions (Kirzner, 1997: 71). Hayek (1945: 546) argued that the "knowledge of the relevant facts is dispersed among many people" and the price mechanism can act to coordinate the actions of people within the market. Entrepreneurship is the process through which prices are altered and new knowledge of potential opportunities, perhaps as the result of error, is disseminated across market participants. Further conflict with the neoclassical microeconomic approach is also apparent here. The assumption of perfect information, where all of the information needed for a decision is at the individual's disposal, within the neoclassical paradigm means that no decision can be truly mistaken (Kirzner, 1997: 72); as Hayek (1937) expresses it, "we all realise that the concept of [neoclassical] equilibrium itself can be made definite and clear only in terms of assumptions concerning foresight". Entrepreneurial errors in the Austrian approach, perhaps occurring due to a lack of 'foresight', cause discrepancies in price and supply that result in a misallocation of resources; alert entrepreneurs can then capitalise on these opportunities for profit. These errors tend to be eliminated over time, as market experience tends to reveal the infeasibility of some actions due to the dissemination of knowledge through market participation (Kirzner, 1997: 71).

Furthermore, Kirzner (1997: 71) makes the claim that an opportunity for pure profit from entrepreneurial error “by its nature, [cannot] be the object of a systematic search”. To substantiate this claim, he draws a distinction between known ignorance and unknown ignorance. Regarding the former, one can conduct a search for missing information, as individuals are aware of the information that they lack; unknown ignorance characterises entrepreneurial opportunities for pure profit, as “one is not aware that one has missed the grasping of any profit” (Kirzner, 1997: 71). Accordingly, the Austrian perspective suggests that it is discovery and surprise that “characterises the entrepreneurial process of the equilibrating market” (Kirzner, 1997: 72). Austrians also insist that “the entrepreneurial market process may indeed reflect a systematically equilibrative *tendency*, but this by no means constitutes a *guaranteed* unidirectional, flawlessly converging trajectory” (Kirzner, 1997: 72, original emphasis). This is an important distinction between the Austrian and Neoclassical approaches to competitive markets. The Neoclassical School posits that equilibrium tendency is the logical inevitability of competitive markets given the conditions and constraints that market participants face and their utility maximising behaviour. However, the Austrian approach suggests that market conditions and constraints are in a constant state of flux, due to changes in tastes, resource availabilities, and technological possibilities. Furthermore, the possibility of entrepreneurial error, a manifestation of human fallibility in the face of uncertainty, doesn’t necessarily guarantee that the behaviour of market participants is always optimal or tending toward equilibrium. Thus, Austrian’s develop a theory of competitive market processes that are substantially more dynamic than those suggested by neoclassical theory.

These processes result in markets beset with a form of *rivalrous competition* that differs drastically from the neoclassical depiction of competition:

“Austrians are at pains to emphasise the dynamically competitive character of such a process. The process is made possible by the freedom of entrepreneurs to enter markets in which they see opportunities for profit. In being alert to such opportunities and in grasping them, entrepreneurs are competing with other entrepreneurs. This competition is not the competitive state achieved in neoclassical equilibrium models, in which all market participants are buying or selling identical commodities, at uniform prices. It is, instead, the rivalrous process we encounter in the everyday business world, in which each entrepreneur seeks to outdo his rivals in offering goods to consumers” (Kirzner, 1997: 73)

Three aspects of this definition are central to the Austrian conception of competition and its relation to the market behaviour of economic agents. First, an emphasis on ‘dynamism’, suggesting states of competition that are always changing, is perhaps where the Austrian and neoclassical approaches differ the most. Perfect competition in the neoclassical sense is characterised by firms operating in a market with many other firms, who are all price takers selling homogenous goods and facing perfectly elastic demand curves. Thus, competition in this sense is really the description of a state of affairs that is believed to maximise welfare. Stigler (1957) laments this view of competition in neoclassical economic theory, suggesting that the concept of competition became ‘confused’ with “a perfect market, uniqueness of equilibrium, and stationary conditions”. Moreover, “the merging of the concepts of competition and the market are unfortunate, for each deserved a full and separate treatment”; this ‘merge’ can be attributed to Jevons and was imitated by others, such that “a market is commonly treated as a concept subsidiary to competition” (Stigler 1975: 6). Reference to stationary conditions implies stability, such that they persistently replicate themselves through time and are constant by nature. However, rivalrous competition in the Austrian sense emphasises the ever changing nature of competitive conditions, where firms must relentlessly adjust their behaviour according to entrepreneurially driven changes in market conditions; the emphasis here lies on the how entrepreneurship incentivises firms to behave in particular ways, as opposed to hypothetical conditions of a particular market state. This leads to the second aspect central to Austrian rivalrous competition, the process of competition in the ‘everyday business world’ where entrepreneurs seek to outdo their rivals. Entrepreneurial decision making is a key component of rivalrous competition, as entrepreneurs must decide on how to best ‘outdo’ their competitors, by judging the uncertain outcomes of their decisions and stating preferences regarding these outcomes. There is a clear game theoretical component to Austrian rivalrous competition and it is reminiscent of Mill's conception of entrepreneurial behaviour in competitive markets. This competition is not present in neoclassical models due to the constraints placed on market behaviour as a result of the assumptions of the models.

However, an aspect that perhaps unites these two conceptions of competition is the importance placed on the 'freedom of entrepreneurs to enter markets'. In the neoclassical approach, this was an essential characteristic to ensure that only normal profits were accrued by operating firms and that price would equate to cost in the long run. In the Austrian thesis, it is not profit itself but the perceived opportunity for profit that is the key driver of entrepreneurial entry, however such perception is formed. This entry is the true nature of Austrian competition, as it results in rivalry between existing firms and new firms that could perhaps do things better, and it is this that drives firms in competitive markets. It is perhaps indicative of the importance of entrepreneurship to the performance of competitive markets that the 'freedom of entrepreneurs to enter markets' is an aspect that is consistent across the disparate neoclassical and Austrian theories; even Mill's statement of classical political economy saw the importance of the threat of entrepreneurial entry in the process of price formation in competitive markets. That each of these schools of thought highlights the importance of entry by nascent entrepreneurs to the competitive market process perhaps highlights the importance of entrepreneurship to a fully functional market economy.

Whilst there is much more to the Austrian School of thought, this section has examined the key aspects of Austrian theory in relation to entrepreneurship. The Austrian approach differs from mainstream economic thought, represented through the Neoclassical School, in its methodological approach; whilst retaining a subjective theory of value and the concept of marginal utility, Menger pushed subjectivism to its extreme limits by rejecting utilitarian principles and creating a 'value free' economic science. Moreover, there is a significant philosophical dimension concerning the free will of human action in an 'open-ended' world that is beset with uncertainty at every turn. Building on the work of von Mises, who envisaged the market as an entrepreneurial driven process, and Hayek, who emphasised market participation as a discovery process characterised by dispersed knowledge, Kirzner (1973; 1997) develops a concept of 'entrepreneurial discovery' that is distinctly Austrian. Central to this thesis are the concepts of (i) the entrepreneurial nature of human action in an uncertain world; (ii) the role of discovery in the entrepreneurial processes that are the feature of an equilibrating market; and (iii) the presence of rivalrous competition that results from entrepreneurial decision making in competitive markets. These culminate in a theory of competitive markets that are entrepreneurially driven, emphasising the fundamental importance of entrepreneurship to a functioning, enterprise led market economy.

3.5 – Conclusion

This chapter has sought to analyse the contributions of Joseph Schumpeter, Frank Knight and the Chicago School, and the Austrian School to the field of entrepreneurship in economic theory. These three approaches, which had misgivings about some fundamental tenets of the neoclassical approach, appear to attribute entrepreneurship a vital role in economic affairs; specifically, entrepreneurship is seen as an important component of economic development and the functioning of competitive markets. To Schumpeter, the 'Creative Destructive' of the entrepreneur through the implementation of 'new combinations', "new ways of using existing means or factors of production" (Swedberg, 2007), destroys static conditions and is responsible for economic development; this is the is the fundamental nature of capitalism. The approaches of Frank Knight and the Austrian School appear to have much in common; in fact, Hunt (1979) emphasises the similarities between both the Austrian School, epitomised by von Mises and Hayek, and the Chicago School, epitomised by Frank Knight and later Milton Friedman, in that they share a mutual emphasis on "the universal beneficence of exchange, extreme individualism, and a doctrinaire advocacy of laissez-faire" (Hunt, 1979: 429). The main difference that distinguished these two schools as they developed was methodological, whereas the Austrians generally advocate a rationalist approach, Milton Friedman and the Chicago school emphasise an empirical approach (Hunt, 1979: 429). Both of these schools of thought emphasise the role of uncertainty in economic affairs, and entrepreneurship is an expression of human agency in an 'open ended world'. The entrepreneur might be considered as someone who faces an uncertain income, but this would possibly be an oversimplification; as Hebert (1985) indicates by quoting Austrian economist Ludwig von Mises: "no proprietor of any means of production, whether they are represented in tangible goods or money, remains untouched by the uncertainty of the future". Again, this reiterates the need to focus on entrepreneurship as a form of behaviour as opposed to a specific person. Thus, entrepreneurship takes on a much deeper philosophical significance in both the Chicago and Austrian schools of thought.

4

Chapter 4 – Contemporary Approaches to Entrepreneurship

4.1 – Introduction

The purpose of this chapter is to outline more recent developments in entrepreneurial theory within the economics literature. Whilst the previous chapters concentrated on the methodological and epistemological foundations of neoclassicism and rival schools of thought, of which entrepreneurship formed an aspect of the discussion, the approaches discussed in this chapter embrace the methodological and epistemological tenets of contemporary economics; namely, an emphasis on empiricism (Caldwell, 1982). This emphasis on the application of empirical methods, or at least the statement of postulates that are empirically verifiable in principle, certainly unites the following approaches to entrepreneurship. These approaches seek to 'explain' the 'causes' of entrepreneurship using a set of explanatory variables that are quantifiable. Thus, they find their foundation within a deterministic conception of human behaviour. Of course, one problem with utilising an empirical methodology is that entrepreneurship must be defined in a strict enough sense that it can be measured empirically and used as a dependent variable. This represents a substantial hurdle in itself, as it is no longer sufficient to just associate entrepreneurship with broad concepts such as arbitrage or the bearing of uncertainty; instead, it becomes necessary to be able to theorise how such behaviour manifests itself in reality. There are different approaches to this problem, and they will be discussed in greater detail in the following sections.

The empirical approaches presented here culminate in two approaches to entrepreneurship that are of fundamental importance to the KBE. Section 4.2 will analyse psychology based approaches to entrepreneurship, with a particular emphasis on risk taking propensity and the need for achievement (nAch). Section 4.3 will analyse occupational choice models of entrepreneurship that utilise the methodology of mainstream economics, but nonetheless state postulates that can be, and indeed have been, tested empirically. Section 4.4 discusses the Knowledge Spillover Theory of Entrepreneurship (KSTE) and its role in the dynamic spillover of knowledge, an important aspect of modern endogenous growth theory. Section 4.5 will discuss the nature of human capital and entrepreneurial ability in the theory of Theodore Schultz and how it relates to entrepreneurship. Section 4.6 will summarise and conclude, as well as drawing broader conclusions based on the preceding chapters, with the purpose of providing a workable definition of entrepreneurship for use in empirical research.

4.2 – Psychology Based Perspectives

According to Shane (2000) there is a substantial branch of research that incorporates psychological theory into entrepreneurship, suggesting that entrepreneurial activity is a behavioural response to characteristics that the individual possesses. These theories assume that entrepreneurial activity is determined by the attributes, ability, and willingness of people to take entrepreneurial action (Shane, 2000). Focusing on the characteristics of the entrepreneur is understandable; indeed much historical work focussed on the personality characteristics necessary for successful entrepreneurship, such as judgment, foresight, creativity, and risk taking propensity. For example, Cantillon highlighted the willingness to undertake risk, Schumpeter emphasised leadership and the drive to do things differently, and Knight stressed judgement and foresight as key characteristics for successful entrepreneurial behaviour. This approach is also attractive due to the observable and, to some extent, measurable nature of the characteristics involved. This has led to a number of experimental, empirical studies that have sought to inductively ascertain the effects of certain attributes on entrepreneurial activity in a method akin to the natural sciences, thus representing a methodological shift from the mainly theoretical approaches discussed so far. This approach, as with empirical approaches generally, is rooted within a deterministic view of entrepreneurship i.e. what attributes ‘cause’ people to behave entrepreneurially. Within this framework, certain “enduring human attributes… lead some people and not others to be entrepreneurs” (Shane, 2000); amongst others, several of the most prominent attributes researched are ‘risk taking propensity’, ‘achievement need (nAch)/motivation’, ‘tolerance for ambiguity’, ‘locus of control’, and ‘self-efficacy’. This approach has less emphasis on the function or role entrepreneurship plays in economic life, instead looking at the supply of entrepreneurs. The two psychological traits typically the subject of analysis in the literature are ‘risk taking propensity’ and ‘achievement need/motivation’ (nAch), and these are now examined in greater detail.

As much historical theory regarding entrepreneurship emphasised decision making under risk/uncertainty as a defining feature of entrepreneurship, including the work of Cantillon, Knight, and Kirzner, it is logical that contemporary theory analyses the propensity to take risks. Although Knight emphasised that entrepreneurship was concerned with uncertainty and not risk, it is typically risk that is examined. In an experimental context, this usually involves asking participants to make a choice between a number of possible outcomes with associated probabilities attached to them, where a lower probability of a favourable outcome signifies a greater risk. Empirical evidence regarding risk propensity is somewhat mixed. Some studies (Hull, Bosley and Udell, 1980; Shane, 1996; Stewart*, et al.*, 1999) show that risk propensity is an important determinant of entrepreneurship, whilst others (Brockhaus, 1980; Miner and Raju, 2004; Palich and Bagby, 1995) fail to find such a relationship.

Stewart and Roth’s (2001) ‘Meta-analytic Review’, the practice of mathematically cumulating the results of previous studies and combining them into an overall analysis, indicates that entrepreneurs have a higher propensity to undertake risks relative to their managerial counterparts. This difference is even more pronounced with entrepreneurs whose principal motivation is profit and growth, as opposed to entrepreneurs who are current income orientated. However, Milner and Raju (2004) are critical of Stewart and Roth’s (2001) findings and perform another meta-analysis utilising 14 studies that were absent from Stewart and Roth's (2001) piece. The study concludes that entrepreneurs are in fact 'risk avoidant', a complete contradiction to Stewart and Roth (2001).

Such contradictions highlight the difficulty in taking an experimental approach with psychological characteristics, as differences in outcomes can sometimes be attributed to differences in method. Thus, the inconsistency of results may largely be due to limitations with the data collection techniques and the lack of reliability regarding objective measurements of psychological traits (Entwisle, 1972). For example, the nature of risk and uncertainty as discussed by Knight (1921) is relevant here. If there is no objective basis for calculating probabilities relating to uncertain outcomes and the critical feature of entrepreneurship is that the entrepreneur bears uncertainty and not risk, the objective measurements of risk in these tests are inappropriate.

Achievement motivation, or 'need for achievement' (nAch), has been consistently hypothesised as a determinant of entrepreneurship. According to Jackson (1967), nAch is evident in an individual who "aspires to difficult tasks; maintains high standards; works toward the attainment of distant goals; responds positively to competition; or is willing to put forth effort to attain excellence" (Jackson, 1967, cited in Stewart *et al.*, 1999). These desires appear Schumpeterian in nature by appealing to a higher, philosophical motivation to entrepreneurship. Murray (1938, cited in Stewart *et al.*, 1999) established nAch as a "basic need that influences human behaviour", leading McClelland (1961; 1965, cited in Stewart *et al.*, 1999) to "establish the construct in the entrepreneurship literature by positing that a high nAch predisposes a young person to seek out an entrepreneurial position."

The methods used to measure nAch vary across the studies, although the use of qualitative, self-reported, questionnaire based data assessing the presence of certain psychological traits associated with nAch amongst entrepreneurs is common (Hornaday and Aboud, 1971; Stewart*, et al.*, 1999). Evidence relating nAch and entrepreneurship appears much more consistent than that regarding risk propensity, as most research presents evidence of a positive relationship between nAch and entrepreneurship; this research includes Hornaday and Aboud (1971), Stewart, *et al*. (1999), and Zhao and Seibert's (2006) meta-analysis. A notable exception is Shane (1996), who could not find evidence in any of his twenty regression models that nAch played a significant role in determining the rate of entrepreneurship. However, Shane's (1996) methodology differs significantly from the others presented, as he applies an econometric analysis using US data during the period 1899-1988, in contrast to the experimental approaches of other research. Furthermore, he utilises a fairly simple measurement of nAch for each decade of the time period studied based on McClelland's (1975, cited in Shane, 1996) previous research and this may account for the much of the difference observed between the results.

Thus, there is some evidence that the presence of certain psychological traits, such as risk taking propensity and nAch, can be conducive to entrepreneurial behaviour; however this evidence is sometimes inconsistent and contradictory. There are two methodological issues regarding the approaches discussed here. The first relates to the difficulty in measuring the presence of psychological traits, in that the methods used are sometimes inadequate and ineffective. For example, Entwisle (1972) is critical of studies using self-reported tests aiming to measure nAch for a number of reasons: they exhibit low reliability and predictive validity, exhibit possible correlations with other variables, such as IQ, that are rarely controlled for, results are sensitive to sample size, participants are unable to accurately report on their motivational states, tests are susceptible to "faking", and the fact that the results of the tests do not always correlate with one another despite the assertion that they are measuring similar things. Entwisle's (1972) criticisms illustrate the difficulty in quantifying intangible psychological states and the inconsistency of results from research concerning the relationship between personality traits and entrepreneurship are arguably caused by the shortcomings of experimental approaches, as opposed to a lack of theoretical validity.

The second methodological issue relates to the nature of the relationship between the presence of certain psychological traits and entrepreneurial behaviour; specifically, whether it is a causal relationship or a selection effect. The possible causal nature of the relationship is relatively straight forward, in that a high risk taking propensity and/or a high nAch would cause people to behave in an entrepreneurial manner; however, the presence of a selection effect would suggest that entrepreneurial positions attract people with certain psychological characteristics. For example, Littunen's (2000) interpretation of McClelland's (1961) nAch is that "the theory suggests that individuals with a strong need to achieve often find their way to entrepreneurship and succeed better than others as entrepreneurs." Acting as an entrepreneur and being successful as an entrepreneur then feeds back to reinforce certain personality traits and enhance their prevalence. Accordingly, Littunen (2000) followed a methodology that assumed a selection effect between entrepreneurial positions and nAch, interviewing the entrepreneurs of 138 metal industry and 62 business services start-ups from 1990, followed by five subsequent studies from 1992-1996 where the interviews were repeated. Interviewees were required to assess their 'work ethic', 'pursuit of excellence', 'mastery', and 'dominance' on a 5 point Likert scale. The empirical results suggest that "becoming an entrepreneur and acting as an entrepreneur are both aspects of the entrepreneur's learning process, which in turn has an effect on the personality characteristics of the entrepreneur" (Littunen, 2000). From this perspective, a selection effect can be posited to exist between the proclivity to partake in entrepreneurial activity and a person's personality traits, in addition to a causal relationship that is also sometimes assumed. Whilst disentangling the exact nature of this relationship is beyond the scope of this thesis, as entrepreneurial personality traits are not the subject of the spatial econometric analysis to come, it is nonetheless important to consider the complexity of the relationship between certain personality traits and entrepreneurial activity.

4.3 – Occupational Choice Models

Despite entrepreneurship lacking a place in the theoretical models of the neoclassical paradigm (Hunt, 1979; Screpanti and Zamagni, 1995), a strand of literature has developed employing a methodological approach akin to neoclassical theory that has entrepreneurship as its focal point. This research can be characterised by two features. First, the work begins from sets of axiomatic assumptions where conditions and outcomes of the models are formally deduced, stemming mainly from the assumption of perfect information (Audretsch and Keilbach, 2008b: 238), whereby entrepreneurial opportunities are known by and available to everyone. Second, these models tend to treat entrepreneurship as a form of occupational choice, often where the opportunity cost of a risky entrepreneurial profit is a certain wage in employment. Whilst there is more to entrepreneurship than 'choosing' it as an occupation, this is usually accepted from the outset in this approach. Within this framework, it is the fundamental attributes of people, rather than information about opportunities, that determines who becomes an entrepreneur (Shane, 2000). This work often draws its theoretical basis from Knight (1921) in a framework where the attributes of people (e.g. risk preference) interacts with economic variables (e.g. wage levels). This approach is often contrasted with Schumpeter, as Schumpeter's entrepreneur involves the *changing* of economic constraints through his creative destruction, as opposed to acting *within* constraints. Such entrepreneurship would be difficult to model formally using deductive, mathematical abstractions.

Two major pieces of literature that directly consider the entrepreneur utilising this methodology are Kihlstrom and Laffont (1979) and Evans and Jovanovic (1989). Kihlstrom and Laffont (1979) "construct a competitive general equilibrium theory of the firm under uncertainty which is based on an entrepreneurial model having its historical roots in the work of Knight", centred on the concept of expected utility maximisation. Several assumptions are made; first, "for each firm there is an expected utility maximising entrepreneur who makes decisions for the firm"; second, it is assumed that there can be free-entry by nascent entrepreneurs; third, entrepreneurs have the same access to technology and receive all profits from the firm; fourth, "individuals are assumed to have a choice between operating a risky firm (entrepreneur) or working for a riskless wage (labourer)" and a riskless wage as a labourer is the opportunity cost of entrepreneurship where uncertain profit can be received. It is admitted at this stage that there are "many factors that should influence this choice", including entrepreneurial ability, labour skills, and initial access to capital required to create a firm. However their focus is on risk attitudes, and risk aversion is considered the "determinant which explains who becomes an entrepreneur and who works as a labourer" (Kihlstrom and Laffont, 1979: 720).

Several inferences can be taken from the development of the competitive general equilibrium approach. In equilibrium, more risk averse individuals become workers whilst the less risk averse become entrepreneurs; this result is intuitively obvious given the assumptions made by the model and the fact that the model stems from the work of Knight (1921). What is perhaps more interesting is that "less risk averse entrepreneurs run larger firms and economy wide increases in risk aversion reduces the equilibrium wage", which "adjusts to the point where the supply of workers is equal to the entrepreneurial demand for labour" (Kihlstrom and Laffont, 1979). The suggestion that less risk averse entrepreneurs run larger firms explicitly links risk attitude to firm size, such that entrepreneurial success, in terms of firm size and profitability[2], is higher when greater risk is undertaken. The second part of Kihlstrom and Laffont's (1979) conclusions, regarding the response of wages to entrepreneurship, provides theoretical evidence of the effect of entrepreneurship on real economic variables. The risk aversion of the general population is also seen as important as it is shown that changes to the risk aversion of the population translates to effects on wages levels through the mechanism of entrepreneurship and firm creation. These changes are also easy to envisage; for example, negative exogenous shocks to the economy that reduce the expectations of future profits from entrepreneurship may increase the supply of waged labour, as people elect to seek a certain wage instead of the risky returns to entrepreneurship.

[2] This does make the assumption that profitability increases with firm size, which according to Evans and Jovanovic (1989:811) is empirically valid.

Kihlstrom and Laffont (1979: 746) suggest that that an "interesting alternative interpretation can be made by explaining the differences in risk aversion as arising from differences in wealth". Evans and Jovanovic (1989) do just this by explaining entrepreneurial choice in terms of the effects of liquidity constraints. They separate the capitalist and entrepreneurial functions by considering if people need to be wealthy first in order to start a business. In these models, "an individual must decide whether to work for himself (i.e. become an entrepreneur) or continue to work for someone else (i.e. remain a wage worker)" (Evans and Jovanovic, 1989: 810-811). They also consider the impact of 'entrepreneurial ability', making the suggestion that "an abler entrepreneur has a higher total product and a higher marginal product at all levels of capital" (Evans and Jovanovic, 1989: 811); a model is then developed consisting of constrained entrepreneurs, unconstrained entrepreneurs, and wage workers, and empirical data is used to estimate the models. Several key conclusions emerge. First, the reduced form results suggest that the probability of entrepreneurship through self-employment increases with an increase in assets and this is statistically significant at a 10% level; the effect of assets on the probability of entrepreneurship becomes statistically significant at a 2% level once past wage earnings are considered, supporting similar results obtained by Evans and Leighton (1989). In terms of Evans and Jovanovic's (1989) maximum likelihood estimates, the 'key finding' is that there are binding capital constraints on "virtually all the individuals who are likely to start a business", leading to the conclusion that "wealthier people are more inclined to become entrepreneurs" (Evans and Jovanovic, 1989). That liquidity constraints impact entrepreneurial activity is indicative of the existence of imperfect capital markets, as "entrepreneurship may in fact not be an option for younger workers because they will… have difficulty borrowing funds"; furthermore, this assertion is relevant to public policy, as it is "one of the rationales for government assistance programs to small businesses" (Evans and Jovanovic, 1989: 809). These results highlight the importance of available capital to the entrepreneurial process and that liquidity constraints can prevent those so inclined from starting a firm. In light of these results, Evans and Jovanovic (1989: 825) estimate that total "lost" investment in the US, over the time period analysed, as a result of these constraints discouraging entrepreneurship is approximately $2.7B at 1976 prices. Whilst these estimates are deemed only 'illustrative' and the welfare implications are 'unclear', this loss of investment highlights how the microeconomic issues of entrepreneurship can have significant macroeconomic implications.

Perhaps the main criticism that can be levelled at Kihlstrom and Laffont (1979) and Evans and Jovanovic (1989) is that their approaches relate entrepreneurship to a simple occupational choice and thus lacks the theoretical rigour of traditional approaches to the entrepreneurship. Other researchers, such as Lucas (1978) and Banerjee and Newman (1993), treat entrepreneurship in a similar way, although entrepreneurship itself is not the principal focus of their work. The danger with this practice is that valuable insights to the entrepreneurial process are overlooked. Whilst it is acknowledged that the assumptions of these models are 'oversimplified', the significant empirical findings indicate that there is some truth in these assumptions. However, suggesting that these approaches find their theoretical basis in Knight's (1921) work possibly overlooks important aspects of Knight's thesis; for instance, when faced with Knightian uncertainty it would be very difficult for an individual to formulate an estimate of expected future profits from entrepreneurship to compare to a riskless wage, which is a requirement of occupational choice models.

There are some important inferences that emerge from the results of occupation choice models and from establishing a rigorous, logical basis for explaining entrepreneurship. The most compelling of these is the relationship between entrepreneurship, wealth, and incomes; interestingly, Kihlstrom and Laffont (1979) and Evans and Jovanovic (1989) approach this in slightly different ways. Kihlstrom and Laffont (1979) consider wage income as an opportunity cost of entrepreneurship but discuss how a greater level of entrepreneurial activity will have the effect of increasing the wage rate by reducing the supply of wage workers. However, Evans and Jovanovic (1989) discuss how higher incomes can encourage entrepreneurship by providing start-up capital and reducing capital constraints. Both seem to imply that entrepreneurship is associated with higher incomes, but the direction of causality is different; Evans and Jovanovic's (1989) approach is perhaps more appealing as it makes fewer assumptions about the motivations for entrepreneurial behaviour, only the self-evident observation regarding the need for start-up capital and that higher incomes can contribute to that. It might thus be more appealing to suggest that higher incomes encourage entrepreneurship in this occupational choice context. The ambiguous nature of the relationship between entrepreneurship, wealth, and incomes perhaps highlights the difficulty in applying simplified abstractions to model a multi-faceted form of behaviour such as entrepreneurship.

4.4 – The Knowledge Spillover Theory of Entrepreneurship

Shane and Venkataraman (2000) declare that "entrepreneurship is concerned with the discovery and exploitation of profitable opportunities." However, the consideration of multiple factors such as personality characteristics, decision making under uncertainty, and the effects of the entrepreneurial process has resulted in an abundance of "incomplete definitions" of entrepreneurship "that do not withstand the scrutiny of other scholars" (Gartner, 1989). In light of these issues, it was perhaps needed to alter the focus of entrepreneurial theory and consider the source of entrepreneurial opportunities. This is a fundamental aspect of entrepreneurial theory addressed by the Knowledge Spillover Theory of Entrepreneurship (KSTE); here, the underlying 'cause' of entrepreneurial behaviour is the existence of the opportunity, not the presence of the entrepreneur.

The KSTE attempts to unify two disparate literatures within economics, the first being endogenous growth theory and the second entrepreneurial theory. Endogenous growth theory (Romer, 1986; 1990) and the knowledge production function (Griliches, 1979) assume the firm to be an exogenous entity creating new knowledge through investment in Research and Development (R&D) and, endogenously creating new opportunities within the economy. New knowledge created from the "purposeful investment in new knowledge by profit maximising firm's acts as an input into the process of generating economic growth" (Acs*, et al.*, 2009). However, the entrepreneurship literature suggests that it is the opportunities that are exogenous; the firm is an endogenous response to the characteristics of the individual. Understandably, discussion of entrepreneurship has centred on this individual context and the recognition of opportunities (Audretsch and Keilbach, 2008b).

Although Austrian entrepreneurial theory (Kirzner, 1973; 1997) extensively discusses entrepreneurial opportunities, its focus centres on how the process of recognising entrepreneurial opportunities is vital to the market process. Reconciling the differences between endogenous growth theory, where the firm is the unit of analysis, and the entrepreneurship literature, where the individual is the unit of analysis, is possible when it is considered that the firm and the individual are not totally separable and independent (Audretsch and Keilbach, 2008b). This was first suggested by Audretsch (1995) who introduced the KSTE, which posited that "entrepreneurship is an endogenous response to opportunities generated by investments in new knowledge made by incumbent firms and organisations, combined with their inability to fully and completely exhaust the ensuing opportunities to commercialise that knowledge" (Audretsch, Keilbach and Lehmann, 2006). Thus, new 'un-commercialised' knowledge produced by incumbent firms creates new entrepreneurial opportunities.

The KSTE is intimately linked to the role of knowledge in endogenous growth theory and innovation. Endogenous growth theory applies the general underlying assumption that "newly created knowledge is automatically available to all agents in the economic process" (Audretsch and Keilbach, 2008a). In this context, "knowledge behaves like a public good" and all knowledge that is created will increase economic growth due to its increasing returns (Audretsch and Keilbach, 2008a). However, the 'Swedish paradox' (Ejermo and Kander, 2006), suggests knowledge investments do not necessarily translate into higher rates of "balanced growth and competitiveness" (Audretsch and Keilbach, 2008a). This paradox is representative of the wider discussion regarding the relationship between R&D expenditures and growth and the institutions and processes responsible for translating R&D output into economic growth (Ejermo and Kander, 2006).

Similarly, Audretsch and Keilbach (2008b) present the 'Innovative paradox' concerning insights of the 'Knowledge Production Function' (KPF) (Griliches, 1979). This most "prevalent model of technological change" posits that "incumbent firms engage in the pursuit of new economic knowledge as an input into the process of generating the output of innovative activity" (Audretsch and Keilbach, 2008b). Griliches (1979) emphasises that measuring the impact of the most significant source of new economic knowledge, R&D, on productivity is very difficult at both the macro and micro level. However, the general consensus is that innovation from new economic knowledge has a positive impact on productivity and economic growth. The 'Innovation Paradox' stems from the 'considerable' evidence that suggests that small firms play an important role in producing innovative output despite their relatively low spend on R&D (Audretsch and Keilbach, 2008b). Evidence is somewhat lacking that is suggestive of "increasing returns to R&D expenditure", a fundamental feature of endogenous growth theory, and with a 'few exceptions', diminishing returns are the rule (Audretsch and Keilbach, 2008b: 336). Resolving the 'Innovation Paradox' does not involve reconsidering the validity of the KPF, but instead reconsidering the 'independence and separability' of the decision making units of the KPF/endogenous growth theory and entrepreneurial theory – that is, the firm and the individual (Audretsch and Keilbach, 2008b: 336).

The discovery process of recognising and evaluating entrepreneurial opportunities is unique to the individual; the firm is an 'inanimate' entity and "cannot engage in discovery", being merely the vehicle within which the individual entrepreneur achieves the exploitation of opportunity (Acs, *et al.*, 2009). Shane (2003) also emphasises that "the collective process is meaningful in the discussions of execution and exploitation, *but not in the discovery process itself."* Bewley's (2001) interpretation of Knight's (1921) thesis also suggests that the collective process of the firm is incapable of discovering entrepreneurial opportunities; clearly, this approach has some precedence in the entrepreneurship literature. The KSTE was formulated partly as a response to these theoretical issues:

"Ideas and knowledge created in one organisational context such as a firm or university research laboratory, but left un-commercialised as a result of the uncertainty inherent in knowledge, serve as a source of knowledge generating entrepreneurial opportunities….When such incomplete commercialised knowledge in incumbent organisations serves as the basis for the entrepreneurial opportunity, the actual entrepreneurial activity, that is the start-up of a new venture, provides the conduit for the spill-over of knowledge from the source….to the new entrepreneurial venture actually exploiting and commercialising that knowledge" (Audretsch and Keilbach, 2007: 1246).

Typically, the process involves an employee leaving an incumbent knowledge-creating organisation to commercialise and profit on knowledge that the incumbent does not consider potentially valuable enough to pursue. The employee appropriates the returns to knowledge through the creation of a new firm to capitalise on the innovation; if the knowledge creating organisation is not fully compensated for the use of the knowledge, through royalty payments for example, the knowledge is said to have 'spilled-over'. Griliches (1992) highlights that knowledge has a high propensity to 'spill-over' with respect to other inputs and resources; the KSTE posits that entrepreneurship is a key mechanism behind the spillover of knowledge.

The KSTE relaxes two assumptions of endogenous growth theory; the first being that "all knowledge is economic knowledge" and the second the assumed existence of inter-temporal knowledge spillovers across firms that yield endogenous growth. Instead, intra-temporal spillovers are said to exist from incumbents to new firm births (Acs*, et al.*, 2009). With regards to the first assumption, there is a gap between new knowledge (K) and 'economic' knowledge (K_c) that is utilised; this gap is termed the 'Knowledge Filter'(Acs*, et al.*, 2009) and represents the stock of entrepreneurial opportunities. The knowledge filter exists due to the unique properties that knowledge exhibits, as well as the various factors that cause the divergent expected values of knowledge exhibited across individuals, some of which are discussed later.

In a seminal paper, Arrow (1962b) outlined several properties of knowledge. First, Arrow (1962b) suggests that a "given piece of information is by definition an indivisible commodity", as the cost of another economic agent reproducing this information is often zero or at least suitably low, thus effectively being a non-rival good. As such, "classical problems of allocation in the presence of indivisibilities are present here" (Arrow, 1962b). Not all of the economic rewards from the use of knowledge can be accrued privately and there will be significant social externalities as a result of its production; in this instance, investment in the creation of new information/knowledge will be sub-optimal. Second, Arrow (1962b) suggests that non-excludability was also a fundamental feature of knowledge, as "no amount of legal protection can make a thoroughly appropriable of something so intangible as information. The very use of knowledge in any productive way is bound to reveal it, at least in part" (Arrow, 1962b: 615). Thus, it would appear that knowledge has the fundamental features of a public good that is available to everyone and can never be exhausted, a major implication of which is that a sub-optimal private investment in knowledge production might result. These insights have formed the basis of modern growth theories, epitomised by the Romer (1986; 1990) and Griliches (1979; 1992). Both of these approaches highlight the presence of inter-temporal knowledge spillovers and the propensity for third party firms to utilise knowledge that they paid no part in producing, which gives knowledge the increasing returns needed for endogenous growth (Audretsch and Keilbach, 2007; Audretsch and Lehmann, 2005).

However, a consequence of the 'preoccupation' with "the non-excludability and non-exhaustibility" of knowledge (Arrow, 1962b) is that it "neglects another dimension by which knowledge differs from the traditional factors of production": a greater level of uncertainty and a higher extent of asymmetries regarding its value (Audretsch and Lehmann, 2005). The expected value of new knowledge is subject to a greater variance than is associated with other productive inputs, such as the expected increase in productivity from a particular capital investment. According to Arrow (1962b), this uncertainty not only shows itself on the supply side, concerning knowledge production, but also on the demand side. A "potential buyer will base his decision to purchase information on less than optimal criteria", as the value of information is unknown to the buyer until he has the knowledge, at which point they have already acquired it "without cost" (Arrow, 1962b).

Asymmetries concerning the value of new ideas are largely caused by 'divergences' in education, background, and experience, leaving a proportion of knowledge un-commercialised and accentuating the knowledge filter (Audretsch and Lehmann, 2005). Divergences in the perceived values and heterogeneity among individuals result from differences in "access to information, cognitive abilities, psychological differences, and access to financial and social capital" (Audretsch and Keilbach, 2008b: 328). Similarities with Schultz's (1975; 1980) conception of entrepreneurial ability, discussed later, can be seen here, such that it can possibly be viewed as complementary to the KSTE process. Additionally, the knowledge filter is enlarged by a "broad spectrum of institutions, rules and regulations" (Audretsch and Lehmann, 2005) that result in "a lower volume of *intra-temporal* knowledge spill-overs" (Acs*, et al.*, 2009). Acs*, et al.* (2009) elaborate on these "institutional and individual barriers to entrepreneurship" as including "financing constraints, risk aversion, legal restrictions, bureaucratic and red tape constraints, labour market rigidities, lack of social acceptance etc." Despite not being explicitly specified, these institutional factors 'taken together' constitute barriers to entrepreneurship, discouraging entrepreneurs from pursuing potentially profitable opportunities (Acs*, et al.*, 2009).

'Barriers to Entrepreneurship' are a recurrent theme in the KSTE, despite being loosely defined. Acs*, et al.* (2009) specify three types of barrier in their cross country analysis, 'public expenditure in relation to GDP' and 'tax share in GDP' for both individuals and corporations, to measure general economy-wide tax burdens and regulatory pressure; however, the empirical results regarding the effects of these barriers are inconclusive. The insights into 'barriers of entrepreneurship' form a part of a wider discussion on how regulatory and bureaucratic barriers work in favour of incumbents to the detriment of potential start-ups (Klapper, Laeven and Rajan, 2006). Furthermore, the concept can be linked to how the effects or absence of certain forms of social capital can have a detrimental effect on entrepreneurial activity. Whilst "the concept of social capital is widely agreed to be ambiguous" (Casson and Giusta, 2007), Bowles and Gintis (2002) argue that "social capital generally refers to trust, concern for one's associates, a willingness to live by the norms of one's community and to punish those who do not"

(Bowles and Gintis, 2002: F419). This emphasis on conforming to community values can have important implications for spatial variations in entrepreneurship and there have indeed been attempts to integrate social capital and entrepreneurship within a spatial context. For instance, Westlund and Bolton (2003) define ‘space bound social capital’ as “spatially defined norms, values, knowledge, preferences, and other social attributes or qualities that are reflected in human relations” (Westlund and Bolton, 2003: 79). Westlund and Bolton (2003) continue by specifying how ‘space bound social capital’ can influence entrepreneurial activity through considering both Becker’s (1996, cited in Westlund and Bolton, 2003: 79) and Coleman’s (1990, cited in Westlund and Bolton, 2003: 79) concepts of social capital. To Becker (1996), social capital “consists of preferences, created by past experiences, which directly yield welfare rather than merely casually contribute to the production of other things that yield welfare” (Westlund and Bolton, 2003: 79); here, social capital effects an individual’s utility function by directly influencing the utility derived from entrepreneurship. For example, factors such as family expectations or a lack of social acceptance of entrepreneurship might directly decrease the utility an individual derives from entrepreneurial activity; in this sense, certain forms of social capital act as a ‘barrier to entrepreneurship’. To Coleman (1990), “social capital is a resource of the actors, which they use to increase their utility” (Westlund and Bolton, 2003: 79); here, it is links between people within social groups facilitating certain behaviour that constitutes social capital. For example, the presence of local networks facilitating social interactions, which Casson and Giusta (2007) argue is a manifestation of social capital, can help encourage the spread of information regarding entrepreneurial opportunities and provide greater access to the resources needed to appropriate them. Accordingly, the absence of such networks, relative to localities that have them, could also be perceived as a local ‘barrier to entrepreneurship’. However, these considerations do not lend themselves particularly well to the econometric analysis that typifies KSTE research (e.g. Acs, *et al.,* 2009; Audretsch and Keilbach, 2007; Bishop, 2012), as spatially varied local social capital is a largely unobservable phenomenon and thus lacks a meaningful and quantifiable empirical counterpart. This perhaps highlights the difficulty in precisely defining what constitutes a 'barrier to entrepreneurship'.

Moreover, the KSTE emphasises a significant spatial dimension to entrepreneurial activity, as firm births are invariably located in close proximity to the incumbent firm due to advantages associated with local networks and markets, as well as the costs of relocation (Audretsch and Lehmann, 2005). This spatial dimension is enhanced further by the fact that the transmission of knowledge is costly across space (Döring and Schnellenbach, 2006). Accordingly, "spatial proximity may reduce the cost of transmission" such that intra-temporal knowledge spillovers, in the form of a new firm, "may be localised close to the source of knowledge" (Bishop, 2012: 643). Audretsch and Keilbach (2007) also emphasise the local nature of knowledge spillover entrepreneurship, citing Jaffe (1989) and Audretsch and Feldman (1996), arguing that "knowledge spillover entrepreneurship is… spatially bounded in that local access is required to access the knowledge facilitating the entrepreneurial start-up" (Audretsch and Keilbach, 2007: 1249). Furthermore, the spatially bounded spillover of knowledge across firms and industries that yields "convexities in economic activity on the regional level" (Audretsch and Keilbach, 2008a) forms an integral part of endogenous growth theory (Romer, 1986; 1990) and the 'New Economic Geography' of Krugman (1991); that entrepreneurship can act as a source of knowledge spillovers fully embeds entrepreneurship within this literature and makes entrepreneurship an integral component of endogenous growth theory and economic geography. Furthermore, the spatial context applies equally to other aspects of the KSTE; for example, with regards to 'barriers to entrepreneurship', it is hypothesised that "entrepreneurship will be lower in regions burdened with such barriers" (Audretsch and Keilbach, 2008b) and the presence of these barriers can vary significantly across space. Accordingly, much of the empirical work concerning the KSTE uses a particular geographical context as the unit of observation, using data at a country level (Acs*, et al.*, 2009), regional level (Audretsch and Keilbach, 2007), or sub-regional level (Bishop, 2012).

Thus, the main tenets of the KSTE can be stated as follows:

1. *Endogenous Entrepreneurship Hypothesis:* Entrepreneurship will be greater in the presence of higher investments in new knowledge, ceteris paribus (Audretsch and Keilbach, 2008b)

2. *Localisation Hypothesis:* Knowledge spillover entrepreneurship will tend to be spatially located within close geographical proximity to the source of knowledge actually producing that knowledge (Audretsch and Keilbach, 2008b)

3. *Barriers to Entrepreneurship Hypothesis:* Entrepreneurial activities decrease under greater regulation, administrative burdens, and market intervention by governments, as well as other constraints relating to financial and social capital (Acs*, et al.*, 2009).

Many empirical studies of the KSTE (Acs*, et al.*, 2009; Audretsch and Keilbach, 2007; Audretsch and Lehmann, 2005) implement regression models with some measure of entrepreneurship as a dependent variable, where the unit of observation is an administrative geographical area. This immediately raises two methodological issues. First, the measurement of the dependent variable often differs across studies, but usually consists of either regional firm births per capita (Audretsch and Keilbach, 2007; Audretsch and Keilbach, 2008) or the proportion of the regional labour force that is self-employed (Acs*, et al.*, 2009) and often depends on data constraints. Second, the use of spatial units as the unit of observation leads to potential violations of assumptions of regression modelling, such as those regarding the independence of estimation errors. The existence of spatial spillovers, where the variables in a particular region impact on the variables in other regions, can lead to biased estimates and misleading inferences and this should be tested and controlled for with spatial specifications utilising spatially autoregressive components (Anselin, 1988a). This is particularly pertinent in the case of the KSTE as knowledge is assumed to have a high propensity to spillover (Arrow, 1962b; Romer, 1986; 1990).

Different studies take slightly different approaches to the KSTE, analysing its impact in different contexts, utilising different explanatory and control variables, and employing different functional forms. However, the results of the regression analyses are generally supportive of the principles of the KSTE (Acs*, et al.*, 2009; Audretsch, Bönte and Keilbach, 2008; Audretsch, Dohse and Niebuhr, 2010; Audretsch and Keilbach, 2007; 2008a; Audretsch and Lehmann, 2005; Bishop, 2012). Much of this empirical evidence has been supportive of both the *Endogenous Entrepreneurship Hypothesis* and the *Localisation Hypothesis* in particular.

For instance, Acs, *et al.'s* (2009) cross country analysis investigates the main tenets of the KSTE over time, using the proportion of the labour force being classified as self-employed as the dependent variable to approximate entrepreneurship. The 'knowledge stock' of a country was measured through "accumulated R&D flows" and the results are generally supportive of the *Endogenous Entrepreneurship Hypothesis,* such that a positive relationship between knowledge 'stocks' and entrepreneurship is observed. Patent intensity was used to measure the extent of knowledge appropriation by incumbents. If it is assumed that large organisations are responsible for the creation of most knowledge, these organisations are likely to be responsible for the first claims on this knowledge. Arguably, filing for property rights is the first step towards making such claims, such that a higher rate of patent intensity would suggest that a higher proportion of knowledge produced by incumbents is appropriated by incumbents. This reduces the size of the 'knowledge filter' and thus a negative relationship would be posited to exist between patent intensity and entrepreneurship. This is indeed what is found, however the significance of this variable is inconsistent across models. Alternatively, patent intensity could be considered as a measure of knowledge output, as it is usually associated with the production of economically useful knowledge; thus, geographical contexts that have a greater patent intensity could be considered to be more knowledge intensive. The relationship between intellectual property rights and entrepreneurship is an interesting one, particularly given the emergence of the recent phenomena of 'Patent Thickets' (von Graevenitz, Wagner and Harhoff, 2011), and is perhaps deserving of further investigation.

Audretsch and Keilbach (2007) and Bishop (2012) take a similar approach using cross-sectional data, where entrepreneurship is the dependent variable in a linear regression model with regional knowledge as an explanatory variable. Audretsch and Keilbach (2007) take the proportion of the regional labour force that are employed in the R&D industry as a proxy variable of regional knowledge, measuring its impact on general, high-technology, ICT, and low-technology entrepreneurship. The results indicate that the impact of knowledge on entrepreneurship is positive and significant in the high-technology and ICT sectors, but a negligible effect is observed on low-technology sectors and entrepreneurship across all sectors. What this does highlight, in particular, is that the KSTE may be sector specific and only impacts knowledge intensive sectors. Bishop (2012) takes a much broader approach, using entrepreneurship across all sectors as the dependent variable; however, entrepreneurship is measured here through the number of new VAT registrations per thousand of the working population. Regional knowledge is measured by proxy using employment in Knowledge Intensive Services (KIS) and High Technology Manufacturing (HTM). These Knowledge Based Industries (KBI) are deemed such due to their extensive use of ICT and high employment of graduates in accordance with widely accepted Eurostat definitions (Eurostat, 2014); furthermore, it is assumed they are equally as intensive in their production of knowledge. The results suggest that employment in KIS is positively associated with entrepreneurship, whereas greater employment in HTM has a negative effect on entrepreneurship. This sector specific effect, where some KBI sectors are associated with knowledge spillover entrepreneurship to a greater extent than others, might suggest that categorising industries as knowledge intensive as per the Eurostat method is overly simplistic. Alternatively, the contradictory effects of KIS and HTM employment in Bishop (2012) might highlight the potential sector specific relevance of the KSTE in the form of an industry effect. For example, HTM sectors produce goods that are not weightless, and hence the locational decisions of HTM start-ups might consider a greater array factors relating to infrastructure and transportation in addition to the spatial context postulated by the KSTE. Arguably, KIS sector start-ups would not have to take these factors into account to the same degree due to the weightless nature of the goods and services they produce, and hence the spatial context postulated by the KSTE might have a much greater influence. This could account for the opposite effects of KIS and HTM employment observed in Bishop (2012). Moreover, Bishop (2012) also utilises several spatial specifications of the same regressions, however this leaves the statistical inference of the estimated coefficients on the knowledge variables relatively unchanged, adding to the general robustness of the results.

In addition to the 'size' of the knowledge stock, Bishop (2012) alludes to the fact that the constitution of the regional knowledge stock is also an important determinant of knowledge spillover entrepreneurship. This is part of the wider debate regarding the role of related and unrelated diversity (Bishop, 2009; Bishop and Gripaios, 2009). To measure the composition of regional knowledge, Bishop (2012) incorporates indices that measure the diversity of employment across knowledge sectors, and thus the constitution of the regional knowledge stock, decomposed into both Unrelated (KUE) and Related (KRE) Diversity. The results indicate that both unrelated and related diversity exhibit a positive influence on regional entrepreneurship. This is in contrast to general industrial diversity, often used as an explanatory variable in KSTE research (Audretsch, Dohse and Niebuhr, 2010; Audretsch and Keilbach, 2008a), which has a negligible effect on regional variations in entrepreneurship (Bishop, 2012).

Audretsch and Lehmann (2005: 1197) present similar findings when they examine the "spatial relation between knowledge-based start-ups and their proximity to universities" using German data. Here, the *Endogenous Entrepreneurship* and *Localisation* hypotheses are tested simultaneously by assuming that universities create knowledge and that this knowledge is more likely to be utilised in close proximity to the university. The corollary of these assumptions is that significantly more knowledge based start-ups will be located within a defined radius, 1.5km in this instance, of the university. Their regression results confirm this, although there is some variation depending on the research focus of the university. Variations can be seen across the estimated coefficients depending on the universities natural science and social science research output, as well as the relative numbers of natural science and social science students.

Testing the *Barriers to Entrepreneurship* hypothesis and assessing the effects of these barriers on regional entrepreneurship is more difficult. There is a metaphysical difficulty in defining what constitutes a ‘barrier to entrepreneurship’, as technically anything that might have a detrimental impact on the entrepreneurial process can be considered a ‘barrier’. Moreover, many of these barriers are likely to be personal, such that finding aggregated variables on a spatial level that reflect these personal and subjective barriers poses a significant challenge. Acs*, et al.* (2009) consider government intervention in the market as a potential barrier to entrepreneurship, utilising the public expenditure to GDP ratio, personal tax rate, and corporate tax rate as explanatory variables that proxy macro-level barriers. It is hypothesised that these may be negatively associated with entrepreneurship; this is consistently found to a significant level with the public expenditure and personal taxation variables, but not with the corporate taxation variable, which in some regressions is shown to be significantly positive in its marginal effect on entrepreneurship. This highlights the inconsistency of aggregated such macro level barriers and their potential influence.

Thus, the KSTE contributes significantly to entrepreneurial theory, by changing the focus of investigation from the individual who recognises an entrepreneurial opportunity to the source of the opportunity itself. The KSTE declares that due to fundamental aspects of knowledge, in particular its uncertain nature (Arrow, 1962b), there are significant asymmetries regarding its potential value as an input. This uncertainty contributes to the gap between new knowledge and economic knowledge, the ‘knowledge filter’, as a proportion of knowledge created will be left un-commercialised by incumbent firms. This creates an opportunity for an individual who is privy to this knowledge, typically employees of the incumbent firm, to appropriate its potential returns through the creation of a new firm. Additionally, a range of institutional, social, and economic factors, such as tax regimes and the regulatory environment, create ‘barriers to entrepreneurship’ which impede the potential use of knowledge and contribute to the knowledge filter. These concepts also have a significant spatial dimension due to the costly transmission of knowledge over space (Döring and Schnellenbach, 2006), costs associated with relocation and the advantages of local networks (Audretsch and Lehmann, 2005), and the fact that the presence of 'barriers to entrepreneurship' can also vary over space (Acs*, et al.*, 2009). These considerations lead to the development of several empirically testable hypotheses, namely the *Endogenous Entrepreneurship*, *Localisation*, and *Barriers to Entrepreneurship* hypotheses. Current empirical evidence has been consistently supportive of the propositions of the KSTE, made particularly more robust given the variety of methodologies, measurements of variables used, spatial units, and controls that have been utilised. However, issues still need to be addressed that consider spatial autocorrelation issues, defining barriers to entrepreneurship, and the application of the KSTE in different spatial contexts. Retaining the importance of uncertainty and the profit incentive to entrepreneurship ensures that the KSTE preserves aspects of early, traditional entrepreneurial theory; however, its emphasis on knowledge, entrepreneurship, and how this can translate into economic growth places the KSTE directly within the KBE which is becoming increasingly adopted as the model for the modern economy.

4.5 – Human Capital, Tacit Knowledge, and Entrepreneurial Ability

Another branch of relevant literature concerns the effects of human capital investment, education, tacit knowledge, and entrepreneurial ability on the entrepreneurial process. The theoretical foundations of the human capital approach can be found in the equilibrium framework of Theodore Schultz (Hebert and Link, 1989). Schultz postulates that the dynamic economy is "beset with various classes of disequilibria" (Schultz, 1975: 832) and in response to these disequilibria, individuals engage in 'optimising behaviour', reallocating resources to regain equilibrium; any individual who conducts this 'optimising behaviour' is behaving entrepreneurially. Schultz is critical of past attempts to define entrepreneurship on several grounds: "(1) the concept is restricted to businessmen; (2) it does not take into account the differences in allocating ability; (3) the supply of entrepreneurship is not treated as a scarce resource; and (4) and there is no need for entrepreneurship in general equilibrium theory” (Schultz, 1975).

Schultz (1975; 1980) addresses (2) and (3) through an equilibrium based theory of entrepreneurship, developing the concept of entrepreneurial ability and treating it as a scarce resource. Schultz (1975: 828) defines ‘ability’ as “the competence and efficiency with which particular acts are performed”, and our knowledge of a person’s ability is inferred from their performance. By treating entrepreneurial behaviour as a service that is both useful and scarce, it follows it has an economic value. Schultz’s inclusion of entrepreneurial ability into an equilibrium model is described as follows:

> “In analysing the equilibrating activities of people, we postulate that there are economic incentives to reallocate resources, that people respond to these incentives to the best of their ability, and that the difference in their performance is a measure of the difference among people with respect to the particular type of ability that is required. In accordance with this postulate, there is a type of ability that is useful and whose value is some function of the demand and the supply of that ability. (Schultz, 1975: 834)

An individual is in disequilibrium if they are faced with economic incentives to reallocate resources, and the characteristics of the disequilibrium determine the demand for entrepreneurial abilities and consequently the values of these abilities. The demand schedule is a function of the characteristics of the disequilibrium in whichever context is ‘under investigation’ and is characterised by a “high incentive at the outset and as resources are reallocated the incentive to make further adjustments declines” (Schultz, 1975: 834). This diminishing marginal product to entrepreneurial activity suggests a rivalry between Schultz’s entrepreneurs, where those entrepreneurs who act fastest accrue the highest rewards.

Schultz (1975; 1980) suggests that the dynamic economy is beset with disequilibria, in a similar manner to the Schumpeterian approach discussed in Chapter 3 Section 3.2. The important distinction between the two approaches is that Schumpeter envisaged entrepreneurs as the source of disequilibria through ‘creative destruction’, whereas Schultz's entrepreneurs are equilibrating. Schultz is critical of Schumpeter for not 'extending' his entrepreneurial theory to incorporate "all manner of disequilibria" in the economic system (Schultz, 1975: 833). Moreover, Schultz believed that "many disequilibria that are associated with economic growth are endogenous" (Schultz, 1980: 444). There is specific reference to 'Schumpeter's innovator' as an endogenous event that causes economic disequilibria to which Schultz's entrepreneurs respond. Additionally, 'publically financed and organised research' and resulting technological advance is said to be a major source of pervasive disequilibria responsible for much of the demand for entrepreneurship (Schultz, 1980: 444). Knowledge induced disequilibria resulting from organised research will provide higher returns to the first entrepreneurs who can appropriate this knowledge for economic gains; this is suggestive of a degree of 'rivalry' associated with knowledge. As such, this knowledge cannot be considered a pure 'public good' in the same way that Romer (1990; 1994) and Arrow (1962b) consider knowledge i.e. that the use of knowledge by one firm does not preclude its use by another. It would appear that the demand for entrepreneurs in Schultz's approach is related to how opportunities are created and perceived in the KSTE. Furthermore, these disequilibria are inevitable in a dynamic economy and cannot be eliminated through law or public policy. The responses to disequilibria are neither 'routine' nor 'repetitive' (Schultz, 1980) and accordingly, there is a persistent demand for entrepreneurial ability.

The supply schedule of services resulting from entrepreneurially ability depends on "the stock of a 'particular' form of human capital at any point in time" (Schultz, 1975: 834) and is not restricted to a small part of the adult population (Schultz, 1980: 444). Specifically, entrepreneurial ability is the capability to recognise a given 'disequilibrium', analyse its attributes, and reallocate resources in a profitable manner if it is possible to do so (Schultz, 1975; 1980), and this can encapsulate any individual with an incentive to reallocate any resource. Elements of both Say and Marshall can be seen here, as both emphasise the allocation of resources for profit. Investment in education and training, as well as the passing of time that enables people to learn from experience, increases the supply of services resulting from entrepreneurially ability, as the ability of the population to deal with economic disequilibria is increased. Strictly speaking, for a given level of demand, when a particular entrepreneurial ability is scarce i.e. when relevant education and training is absent, the value of this ability will be relatively high. This will provide an incentive for individuals and firms to invest in education and training in order to acquire entrepreneurial ability. This process will continue until the cost of acquiring those skills equates the value of the returns that are acquired through their use i.e. where marginal cost (acquiring entrepreneurial ability) equals marginal return (rewards from entrepreneurship). The result of the process will be the conditions of that particular entrepreneurial equilibrium. Moreover:

> "The effects of education in this connection can be tested empirically, and it is proving to be a strong explanatory variable.... The presumption is that education – even primary education – enhances the ability of students to perceive new classes of problems, to clarify such problems and to learn new ways of solving them" (Schultz, 1980: 835)

Education improves the economic performance of individuals through 'worker effects' and 'allocative effects' (Schultz, 1980: 836). The 'worker effect' of education captures the improved ability of an individual to "accomplish more with the resources at hand"; therefore, "this 'worker effect' is the marginal product of education as marginal product is normally defined, that is, the increased output per unit change in education holding other factor quantities constant" (Welch, 1970: 42). The 'allocative effects' of education include the enhancement of an individual's ability to "acquire and decode information about costs and productive characteristics of other inputs" and accordingly, "a change in education results in a change in other inputs including... the use of some 'new' factors that otherwise would not be used" (Welch, 1970).

The constant creation of new knowledge and persistent technological progress renders past experience and schooling increasingly obsolete. An important facet of constant technological progress is that "the comparative advantage of schooling rises relative to that of learning from experience as technology becomes more complex", as the ability acquired from schooling is both more durable and "more useful in dealing with changes in complex technology" (Schultz, 1975: 446). Thus, individuals in technologically advanced and highly developed countries face a greater incentive to invest in schooling relative to individuals from less technologically developed countries. Nelson and Phelps (1966) also assert this view, suggesting that the "rate of return to education is greater the more technologically progressive the economy." This is particularly relevant to the KBE, where the accumulation of human capital is a fundamental feature, and enhancing entrepreneurial ability is one method through which returns to education can be realised. As a consequence, in a developing economy beset with increasing forms of disequilibria, the capital structure should adjust in favour of the higher relative returns on investment in human capital as opposed to its physical counterpart. This investment is required for economic agents to respond to increasing disequilibria more effectively and successfully maintain economic and technological progression. Schultz (1975; 1980) cites many examples suggesting human capital investment and education can have a significant, positive impact on the effectiveness of entrepreneurial activity and productivity.

These entrepreneurial problem solving abilities 'contribute measurably' to economic performance (Schultz, 1980: 835) and the outcome of this entrepreneurial process is to regain equilibrium, which is similar to Kirzner's (1973; 1997) theory of entrepreneurship. Schultz (1975; 1980) suggests that there is a lack of progress in mainstream economic theory regarding the entrepreneurial process and is critical of general equilibrium theory in that it is not designed to analyse the actions and performances of individuals as they undertake 'equilibrating activities'. General equilibrium theory assumes that the optimising behaviour of individuals is such that equilibrium is regained instantly; this is considered unlikely to be possible and even if it was possible, it not would be 'economic' for an individual to reallocate all of their resources instantaneously (Schultz, 1975: 829). Therefore, there is an important time dimension to equilibrating activity and an individual's performance over this time is dependent on "their efficiency in responding to any given disequilibrium and on the costs and returns of the sequences of adjustments available" (Schultz, 1975: 829) i.e. the application of their entrepreneurial ability over time and their profit from it.

It is Schultz's (1975: 843) belief that "the function of entrepreneurship would be much extended" through an analysis of entrepreneurship within equilibrium models, enabling us to view entrepreneurial supply as a scarce resource. Hebert and Link (1989) state that "Schultz's approach to entrepreneurship is fully in the neoclassical tradition…. because entrepreneurial ability is a useful service, entrepreneurs must [therefore] have an identifiable marginal product." This implies that there "must exist a market for the service in the sense of normal supply and demand functions" (Hebert and Link, 1989). However, Schultz's (1975; 1980) focus on the market as a process through which individuals alter their allocative tendencies according to their ability to do so, whilst suggesting that this process will not proceed to its "perfect equilibrium point" (Schultz, 1975: 444), appears to be slightly more Austrian in nature than being 'fully' in the neoclassical tradition. Hebert and Link (1989) suggest that Kirzner (1973) offers his entrepreneurial theory as a "halfway house between the 'neoclassical' view of Schultz and the 'radical' view of Shackle" (Hebert and Link, 1989); it is perhaps also the case that Schultz (1975; 1980) offers his view as a 'halfway house' between Kirzner's (1973) and 'neoclassical' approaches to microeconomic theory.

If it is considered that market disequilibrium represents an opportunity for economic gains to be made through entrepreneurial activity, the preceding theory is in keeping with other prominent contemporary approaches to entrepreneurship concerning the recognition and exploitation of opportunities (Venkataraman, 1997). Schultz's (1975; 1980) contribution is to suggest how people endowed with varying degrees of human capital can recognise and exploit these opportunities within an equilibrium framework. In this context, entrepreneurial ability is the key feature of human cognition that influences recognition and exploitation. Entrepreneurial ability can be linked with other concepts concerning human cognition that feature in both the literature regarding the role of knowledge in economics and entrepreneurship; specifically, it can be linked with the concepts of tacit knowledge (Cowan, David and Foray, 2000) and prior knowledge (Shane, 2000).

Arguably, human capital in the form of entrepreneurial ability, tacit knowledge, and prior knowledge are similar concepts that form one part of the often used dichotomy regarding the nature of knowledge. Döring and Schnellenbach (2006) highlight the common distinction between two different types of knowledge; explicit knowledge and tacit knowledge. Explicit knowledge describes the subset of knowledge that is easily communicated, whereas tacit knowledge is said to encapsulate knowledge that is 'often used subconsciously' and not easily communicated verbally. Cowan, David and Foray (2000) identify Polanyi (1958; 1967, cited in Cowan, David and Foray, 2000) as introducing the term 'tacit knowledge' and defines it as "[the] component of human knowledge distinct from, but complementary to, the knowledge explicit in conscious cognitive process… [and] form[ing] the context that renders focused perception possible" (Cowan, David and Foray, 2000). The key component of this definition is that tacit knowledge is 'complementary' to codified knowledge, which implies that an individual's perception of codified knowledge is dependent on a unique 'tacit component', naturally relating to how entrepreneurs perceive the potential value of an opportunity in the KSTE. This is reiterated by Collins (1974, cited in Cowan, David and Foray, 2000) who suggests that the "transmission of skills is not done through the medium of written words" and Tsoukas (2005), who suggests that codified knowledge contains a personal coefficient.

According to Cowan, David and Foray (2000), the KBE has made great use of codified knowledge, but this knowledge is inescapably used in a non-codifiable and non-theoretical manner. 'Personal judgement' is used by economic agents in order to apply abstract representations to the world (Tsoukas, 2005) and, according to Gertler (2003), tacit knowledge has come to be recognised as a central component of the learning economy and a key to innovation and value creation. Whilst Cowan, David and Foray (2000) argue that juxtaposing explicit and tacit knowledge in this way oversimplifies the issue somewhat, it does, however, provide a useful conceptualisation of reasons for differences in approaches to similar entrepreneurial opportunities. Specifically, the concept of tacit knowledge suggests that there is a key component of knowledge that resides within people; this tacit knowledge is personal, influences judgement and the way in which people apply their skills and abilities. In the context of entrepreneurship, the way in which people interpret the potential value of a particular innovation, as well as the type of venture they create in order to capitalise on this innovation, could well be dependent on unique tacit knowledge. The same innovations could represent a completely different set of opportunities to a different set of entrepreneurs.

When framed in this way, similarities can be identified with the KSTE and Shane (2000), who highlights the importance of 'prior knowledge' in the entrepreneurial process. This research was primarily concerned with the reasons why some entrepreneurs discover opportunities and others 'miss them', an approach rooted within Austrian economics. Accordingly, Shane (2000) postulates that "different people will discover different opportunities in a given technological change because they possess different prior knowledge", presenting case studies of how several entrepreneurs exploit the same innovation, i.e. the same codified knowledge, differently. Shane (2000) followed 'eight actual business opportunities' that exploited the three dimensional printing (3DP™) process in various ways with various degrees of success. The business applications of this technology ranged from the "manufacture of ceramic moulds for the casting of metal parts" to the "establishment of a chain of stores to make sculptures from photographs" (Shane, 2000). A broad conclusion, supported by anecdotal evidence, is as follows:

> "Prior information, whether developed from work experience, education, or other means, influences the entrepreneur's ability to comprehend, extrapolate, interpret and apply new information in ways that those lacking that prior information cannot replicate (Roberts, 1991, cited in Shane, 2000). Therefore, even if knowledge is disseminated broadly - particularly if it is disclosed in a patent, presented at a scientific conference or known to several individuals who might work in the same laboratory - only some subset of the population possess prior information that will trigger the discovery of a particular entrepreneurial opportunity" (Shane, 2000).

This extract illustrates that a given item of codified knowledge may represent a different set of entrepreneurial opportunities to different people depending on their prior knowledge. Interestingly, reference is made to education and ability, or 'cognitive limits', and the specialisation of knowledge, in determining which entrepreneurs recognise which opportunities. When taken with Schultz's (1975; 1980) concept of entrepreneurial ability, as well as insights regarding tacit knowledge as one half of the potentially dichotomous nature of knowledge (Cowan, David and Foray, 2000), Shane's (2000) insights add to an already compelling case for the role of subjective knowledge and ability in the entrepreneurial process.

Moreover, a spatial dimension can be added to these considerations that is similar to the one posited by the KSTE. Döring and Schnellenbach (2006) propose that it is only explicit knowledge that can be communicated effectively over great distances, "while the transfer of tacit knowledge, if at all possible, involves direct interaction and therefore close spatial proximity" (Döring and Schnellenbach, 2006). The rising marginal cost of transmitting tacit knowledge over distance suggests that tacit knowledge is likely to have a greater impact locally than globally (Cowan, David and Foray, 2000); in other words, tacit knowledge and entrepreneurial ability are likely to be heavily geographically bounded and transferred across space mainly through labour mobility.

This spatial context is further enhanced by the fact that the idiosyncratic differences in abilities and knowledge across people are similarly not uniformly distributed across space or time. Schultz (1975: 835) makes specific reference to how the supply of services from a particular form of entrepreneurial ability in a particular area is augmented by the in-migration of individuals with relatively high abilities. This has two main implications; first, some disequilibria that require a reallocation of resources by entrepreneurs are local phenomenon if an in-migration of entrepreneurs with the relevant abilities is required to deal with it; second, the existence of abilities in various locations different from the location of the disequilibria necessarily implies an asymmetric distribution of necessary entrepreneurial abilities across space and thus a significant spatial dimension to this theory. Put differently, Cowan, David and Foray (2000) argue that tacit knowledge resides in the minds of scientists and engineers and does not travel freely across space, as well as depriving knowledge of its public good qualities as argued by Arrow (1962b) by making it excludable. Institution's that create new knowledge through applied research develop the required tacit knowledge in the scientists they employ in the research process. Thus, a full understanding of knowledge, produced through applied research, should predominantly diffuse across space through the mobility of scientists. This also implies that investment in knowledge creates a tacit component endowed in the employees involved, providing a strategic asset for organisations. This is a reformulation of the spatially bounded nature of the intra-temporal knowledge spillovers discussed in the KSTE; however, it reinforces the spatial context through which knowledge, in this case in tacit form, has greater impact at a local than global level. The spatial asymmetry in the distribution of entrepreneurial ability/tacit knowledge results in a spatial asymmetry in the recognition of given entrepreneurial opportunities, which also has a greater impact locally than globally due to the rising marginal cost of transmitting tacit knowledge over distance (Cowan, David and Foray, 2000). The possible local nature of disequilibria, as well as the local effects of entrepreneurial ability/tacit knowledge, implies a spatial context that is similar to one posed in the KSTE (Audretsch and Lehmann, 2005). Accordingly, it may be hypothesised that regions that are endowed with a higher level of entrepreneurial ability would recognise and deal with entrepreneurial opportunities and disequilibria to a greater extent, and also more efficiently, than other regions.

4.6 – Conclusion

The preceding analysis presents an overview of contemporary empirical approaches to entrepreneurship. All of these approaches seek to explain the ‘causes’ of entrepreneurship within a deterministic framework. The latter two theories presented, the KSTE and the human capital/entrepreneurial ability approach, posit that knowledge is a fundamental aspect causing entrepreneurial behaviour, either through creating entrepreneurial opportunities or through being responsible for their recognition. One of the substantial benefits of these approaches, particularly the KSTE, is that they avoid the metaphysical arguments of precisely what constitutes entrepreneurship. Contrasting theories of entrepreneurship, particularly those in Chapter 2 and Chapter 3, shows that conceptions of entrepreneurship in the economics literature are diverse and often contradictory. Accordingly, it is perhaps unsurprising that there is no consensus in defining entrepreneurship metaphysically, as it appears that the emphasis on the different facets of entrepreneurship depends on purpose, context, and methodological approach. Arthur Cole's (1969, cited in Gartner, 1989) insight is relevant here:

> "My own personal experience was that for ten years we ran a research centre in entrepreneurial history, for ten years we tried to define the entrepreneur. We never succeeded. Each of us had some notion of it – what he thought was, for his purposes, a useful definition. And I don't think you're going to get farther than that" (Gartner, 1989)

This implies that the boundaries of what might be considered 'entrepreneurship' are practical, not metaphysical, and hence depend on context. Arguably, entrepreneurship can be conceived as an allegorical concept that derives its definitional meaning from its association with a wide variety of factors; judgement, foresight, profit, uncertainty, creativity, and innovation to name a few. What is needed is a practical definition of entrepreneurship through its manifestation in reality for use in an empirical analysis, utilised as a dependent variable of a deterministic model. This has typically been achieved in the past through some appropriate measure of firm birth rates (Audretsch and Keilbach, 2007; Bishop, 2012) or self-employment rates (Acs*, et al.*, 2009).

Coase (1937) asked the fundamental question of why firms exist and what determines their size. Where mainstream economics proclaims that factors of production are co-ordinated by the price mechanism at the aggregate level, it can be said that this overlooks the fact that much of the co-ordination of factors is consciously directed and organised within the firm by the "entrepreneur co-ordinator" (Coase, 1937). Firms emerge where the relative costs of organising production through a firm by the entrepreneur are less than the costs of organising on the market through the price mechanism. Therefore, the establishment and organisation of production within a firm can be considered a clear manifestation of people fulfilling the entrepreneurial task. This is acknowledged by Audretsch and Keilbach (2004a; 2004c) who explicitly state that entrepreneurship manifests itself in a singular way; the start-up/birth of a new firm. Firm birth rates are generally used within KSTE research looking to determine variations in entrepreneurship itself (Audretsch and Keilbach, 2007), or to measure a region's 'entrepreneurship capital' when linking entrepreneurship to regional growth or performance (Audretsch, Bönte and Keilbach, 2008; Audretsch and Keilbach, 2004a; 2004b; 2008a). Whilst this doesn't necessary preclude other manifestations of entrepreneurship, firm births can be considered as a suitable approximation.

In conclusion, the analysis of the preceding chapters shows entrepreneurship to be a diverse, multi-faceted, and complex concept. However, there are perhaps some unifying features common to all theories that could be identified. In early theory, the economist's conception of entrepreneurship often reflects the prevailing business practices of the time and this is shown most clearly by contrasting the theories of Cantillon and Say. Cantillon, writing at a time when domestic production was dominant, emphasised the arbitraging, coordinating nature of the merchant entrepreneur, who transferred resources between households to be transformed into finished goods and sold at market for profit. Say, writing at a time when industrialisation was revolutionising production through centralisation within a factory setting, emphasised that entrepreneurship involves both hiring and managing factors. Thus, entrepreneurship begins to take on another dimension when business and productive techniques change with industrialisation.

Two further aspects of entrepreneurial theory that remain consistent are the roles of uncertainty and profit. Knight gives the most comprehensive treatment of uncertainty within economics, defining 'true' uncertainty as instances where probabilities of potential outcomes are not calculable in any meaningful way. Entrepreneurs must emerge and act in the face of this uncertainty by controlling and directing resources to meet uncertain ends; entrepreneurs are the economic manifestation and a consequence of uncertainty in economic life, and an expression of free will in an open-ended world. This might be contrasted with the concept of Knightian risk that involves actions with unknown future outcomes, but the probabilities of these outcomes are calculable. This conception of risk is arguably more prominent in entrepreneurial theory; Cantillon, Say, Mill, and Marshall all discussed the 'risk' involved in entrepreneurial decision making and treated profit as compensation for taking on that risk, and later psychological approaches to the problem explicitly attempted to measure risk attitudes amongst entrepreneurs and non-entrepreneurs. Schumpeter is the only real dissenter, but only insofar as he doesn't believe that risk/uncertainty is the defining or most important feature of entrepreneurship; however he does not negate the fact that the outcomes from entrepreneurial processes are unknown when they are initiated. Whilst it is perhaps misguided to directly contrast uncertainty with risk conventionally defined, as they both require different approaches, both concepts concern future outcomes that are unknown *ex ante*. Thus, the taking control and directing of resources to meet future ends, the outcomes of which are *unknown,* can arguably be seen to unite many aspects of entrepreneurship as treated in the economics literature.

Closely related is the prominence of profit as both an incentive for and residual to entrepreneurial behaviour. Whilst its precise treatment varies, it is consistently present in all of the contributions made towards entrepreneurship within economic theory. Some, such as Cantillon, Mill, and Marshall, envisaged profit as an incentive and the motivational force for entrepreneurial behaviour; others, such as Smith, Say, Schumpeter, and Schultz, suggested that profit should be considered as a return to entrepreneurial behaviour. The Austrian School and Knight emphasised the role of profit-seeking entrepreneurs in uncertain market processes, driving the discovery of knowledge through their entrepreneurial behaviour. Occupational choice models treat risky profit as forming an incentive for entrepreneurship to be compared with a 'riskless' wage. Even the absence of potential profit opportunities in the Walrasian system when markets are in equilibrium leads to the assertion that "the socioeconomic identity of the entrepreneur is irrelevant" (Screpanti and Zamagni, 1995: 167), such is the link between profit and entrepreneurship. In reality, each of these approaches considers profit as some aspect of the entrepreneurial process, but there is no unanimity on the precise nature of the relationship between profit and entrepreneurship.

Furthermore, uncertainty and profit are related as it might be considered that uncertainty about potential profits provides a basis for entrepreneurial behaviour. Later theory concerning the KSTE and human capital combine these aspects. Knowledge is seen to be central to both approaches, as they were developed during the time in which post-industrial economies moved towards the KBE by increasing their investment in knowledge relative to GDP (Brinkley, 2006). The KSTE (Acs*, et al.*, 2009; Audretsch and Keilbach, 2007) discusses the importance of knowledge in creating entrepreneurial opportunities, stressing how the uncertainty of potential profits arising from innovation can cause incumbent firms to be cautious, leaving potentially profitable knowledge available to nascent entrepreneurs to appropriate. Schultz (1975; 1980) emphasises the importance of human capital in the form of entrepreneurial ability, which is similar to concepts of tacit and prior knowledge (Cowan, David and Foray, 2000; Shane, 2000), and its role in the recognition and appropriation of entrepreneurial opportunities emanating from economic disequilibria. Both of these approaches emphasise that knowledge 'causes' entrepreneurial behaviour in some way, and they can also be considered to have a significant spatial dimension due to the costly transmission of knowledge over space and the asymmetric spatial distribution of people with requisite abilities (Döring and Schnellenbach, 2006). Thus, both of these approaches provide empirically testable hypotheses that can be tested in a spatial context using spatial data. The nature of spatial data, particularly in KSTE research, requires that spatial econometric methods are required in order to control for spatial autocorrelation issues that may occur between spatial units of observation, which might violate key assumptions of regression modelling. Interestingly, both concepts may also behave differently over space. For instance, explicit knowledge, perhaps most relevant to the KSTE, describes knowledge that is easily communicated over distance, whereas tacit knowledge, more relevant to the human capital/entrepreneurial ability approach, is said to encapsulate knowledge that is not easily communicated. Accordingly, it might be more necessary to control for spatial autocorrelation issues in a KSTE context, as explicit knowledge might have a higher propensity to spillover between regions.

Thus, the KSTE (Acs, *et al.*, 2009; Audretsch and Keilbach, 2007) and Schultz (1975; 1980) provide concepts of entrepreneurship that are rooted in the issues of modern, knowledge based economies that also adhere to some prior principles of entrepreneurial theory in the economics literature. Moreover, there are several other theories motivated by the literature, mainly relating to diversity, financial constraints, and unemployment that are relevant and deserving of further investigation; these theories also provide several empirically testable hypotheses, and the testing of these hypotheses in a spatial context, utilising newly available data on firm births and spatial econometric methods, will be the focus of the remainder of this thesis. This will address several of the methodological shortcomings of previous empirical work and provide a comprehensive analysis of the determinants of entrepreneurship across GB from 2008-2010; in doing so, the nature of entrepreneurship in the KBE will be brought up to date.

5

Chapter 5 – Research Design, Methodology, and Data Considerations

5.1 – Introduction

This chapter examines the epistemological and methodological issues associated with an empirical investigation of the determinants of entrepreneurship from KSTE and human capital perspectives and discusses the research methods and data utilised in subsequent chapters. Section 5.2 discusses the broad epistemological and methodological considerations of economics as a field of enquiry, with a particular emphasis on how these concerns influence the study of entrepreneurship. Section 5.3 discusses the specific exploratory and econometric methods that will be utilised throughout the remainder of the thesis. Section 5.4 will discuss the data to be used, the specific sources of this data, and provides a general overview of the characteristics of the sample. Finally, Section 5.5 will outline the research strategy of the remainder of the thesis.

5.2 – Epistemological and Methodological Considerations

There are a number of epistemological positions that feature prominently within the economics literature. With the exception of the 'extreme a priorism' of the Austrian School (Caldwell, 1982:104-105), they all advocate some role for empiricism in either establishing or testing the principles of economic science. The Austrian epistemological position, epitomised by von Mises (2003), argues that:

> "Economic science is praxeological, that the basic postulates of the discipline are necessary and unquestionable truths about the human condition; that the status of the fundamental axioms is that of synthetic statements that are a priori true" (Caldwell, 1982:104-105).

This 'apriorist' reasoning can be described as purely conceptual and deductive, whereby "all of the implications are logically derived from the premises and contained in them" (von Mises, 1998). Accordingly, empiricism has no role in establishing or verifying economic laws, such that:

"The validity of economic theory does not stand and fall with empirical investigations. Rather, economic laws are a priori laws that cannot be confirmed or refuted by the methods predominant in the natural sciences. They exist independent of the time and place, and the social scientist comes to know them through pure deductive reasoning" (von Mises, 2003).

Robbins (2007) had a similar position, arguing that;

"The propositions of economic theory, like all scientific theory, are obviously deductions from a series of postulates. And the chief of these postulates are the assumptions involving in some way simple and indisputable facts of experience relating to the way in which the scarcity of goods which is the subject matter of our science actually shows itself in the world of reality" (Robbins, 2007)

However, Robbins admits that 'realistic' empiricism can play some role in economic theory, as it allows economists "to check on the applicability of theoretical constructions to particular concrete situations, to suggest auxiliary postulates to be used with the fundamental generalisations, and to bring to light areas where pure theory can be reformulated or extended" (Caldwell, 1982:102). Thus, whilst Robbins (2007) argues that the ultimate laws of economic science are principles formed through deductive logic from sets of self-evident postulates of human behaviour, it is allowable for 'realistic' empiricism to 'check' postulates and generalisations, and theoretical applicability.

At the other extreme, Terence Hutchinson can be credited with introducing positivism to the economic sciences and in doing so constructing "an objective and value free foundation" for economics (Caldwell, 1982:106). He declares that economics is a 'science', and as such it "must appeal to fact"; if it does not then economists are merely partaking in 'pseudo-science'. Crucially, empiricism is given the prominent place in the development of economic theory; what distinguishes "the empirical propositions of science from those of other intellectual endeavours is their testability" and the truth or falsity of economic statements "must make a difference" (Caldwell, 1982:107). Hutchinson is critical of some propositions of 'pure theory' for they make "no empirical assertion as to the truth [and] are independent of all facts". Furthermore, he rejects the attempts by certain economists to search for more realistic assumptions, based on: (a) the need for 'extensive statistical investigations' in order to discover these more realistic assumptions and (b) given that the "postulates of the equilibrium theory were specially chosen for their tractability", there is no guarantee that more realistic assumptions would be tractable and lead to "any significant chain of deductive conclusions" (Caldwell, 1982:107-108).

Hutchinson's response to the inadequacies of pure theory is unequivocal, advocating the employment of empiricism to study how people form their expectations; in doing so, fundamental economic laws can be inferred from the results. He poses several central questions addressed by economic science, one of which is "whether entrepreneurs behave 'competitively' or 'monopolistically'", and declares that these questions "cannot be assured by any 'Fundamental Assumption' or 'Principle'... ultimately all such questions as these can only be decided satisfactorily by extensive empirical investigation" (Caldwell, 1982:110). Hutchinson rejects the idea that the propositions of pure theory constitute economic laws, and instead offers a "definition of scientific law that is more consistent with definitions of other scientific disciplines". As a result, Hutchinson opposes Robbins's view that the rightful role of empiricism in economic science is to test the *applicability* of the postulates of pure theory, instead embracing the "search for empirical regularities" (Caldwell, 1982:111).

Two further methodological positions emphasise empiricism, Friedman's 'instrumentalism' and Samuelson's 'operationalism'. To Friedman, "the ultimate goal of positive science... is the development of a theory that yields valid and meaningful predictions about phenomena"; these theories should be "logically consistent and contain categories which have meaningful empirical counterparts... [and] must also advance substantive hypotheses that are capable of testing" (Caldwell, 1982:174). Theories should not be judged according to the realism of their assumptions, and should only be tested according to their predictions. Economic theories are merely 'instruments' that are more or less acceptable and accurate according to the predictive adequacy and explanatory power and the extent to which the hypotheses of these theories are confirmed or disconfirmed. In terms of Samuelson's Operationalism, Caldwell (1982:189) declares that two major components of his methodological approach are "that economists should seek to discover 'operationally meaningful theorems'... [and] that there is no explanation in science, only description." Again the emphasis here is on the empirical relevance and falsifiability of theories and how they relate to economic reality; 'operationally meaningful theorems' are said to be defined as hypotheses about "empirical data which could conceivably be refuted if only under certain conditions" (Caldwell, 1982:190).

Thus, a variety of epistemological and methodological positions exist within the field of economic science, ranging from the 'traditional' position of Robbins, the more extreme *a priorism* of the Austrian approach, and the empirically driven positivism of Hutchinson. These rival positions have their advantages and disadvantages, and it is important to remember that there is no 'right' methodological or epistemological position; however some positions are more advantageous than others in consideration of particular research aims and objectives. In economic science, most of the rival positions acknowledge at least some role for empirical studies in the progression of knowledge within the field. In fact, Caldwell (1982:133) argues that "members of the discipline were soon to embrace many of the prescriptions propounded by Hutchinson. His accolades for empirical research and the testing of theories did not fall on deaf ears; his invocations soon became the standard rhetoric of economic methodologists". Indeed, empiricism is even relevant to the highly theoretical system that comprises mainstream economic thought. The components of neoclassical economic theory form a 'hypothetico-deductive' system that, if terms within that system are not given meaningful, empirical counterparts, then "it is nothing more than an empty mechanical calculus"; moreover it is suggested that "the question of empirical content can only be raised once some of the terms are given empirical interpretation"

(Caldwell, 1982:113). There are several unifying features of the various empiricist perspectives in economic science, summarised by Caldwell (1982:123-124) as follows:

> "Whether you are a logical positivist, logical empiricist, or a Popperian falsificationalist in the philosophy of science, four defining characteristics of your methodological view are: that theories should be testable; that a useful means of testing is to compare the predications of a theory with reality; predictive adequacy is often the most important characteristic a theory can possess; and the relative ordering of theories should be determined by the strength of confirmation, or corroboration, of those being compared. If the philosophy of science has had any impact on economic methodology, it is in this area, for most economists are trained to believe in the crucial importance of testing their hypotheses. Indeed, it may be reasonably be conjectured that a majority of economists would consider the construction of theoretical models which are capable of generating testable predictions to be the hallmark of scientific activity." (Caldwell, 1982:124)

There are several reasons why an empirical approach is useful when studying entrepreneurship in particular. First, defining entrepreneurship as a complete and comprehensive economic concept is problematic, and past attempts at doing so suggest that it is almost impossible to establish the defining characteristics of such a multi-faceted concept. Accordingly, it is difficult to establish axiomatic, self-evident postulates that are analytic in nature, from which deductible models can be created. Gartner (1989) reiterates this by stating that "a common definition of the entrepreneur remains elusive". Consequently, the case can be made for an empirical approach to entrepreneurship on the basis that it is easier to 'operationally' define entrepreneurship empirically than theoretically.

For example, Fritz Machlup criticises the use of empirical approaches in economic theory, due to the difficulty of operationally defining many economic concepts (Caldwell, 1982:190). According to Machlup, the consequence of this difficulty is that "theory choice on empirical grounds is problematic if either no empirical counterparts exist for certain theoretical terms, or if a variety exist, and the use of different empirical proxies lead to different predictive results in the theory" (Caldwell, 1982:192). This problem has been reflected in previous empirical research of entrepreneurship through the various methods used to measure entrepreneurship (Acs, *et al.*, 2009; Bishop, 2012).

However, the discussion of the previous chapters suggests it is perhaps easier to 'operationally' define entrepreneurship as the creation of a firm or organisation (Audretsch and Keilbach, 2004a; 2004c), than it is to 'operationally' define many other economic concepts. Gartner (1989:47) concurs with this sentiment, suggesting that "what differentiates entrepreneurs and non-entrepreneurship is that entrepreneurs create organisations." Whilst this might overlook important aspects of entrepreneurial behaviour, it is perhaps the most complete metric of the manifestation of entrepreneurship in economics. This engenders an empirical approach as a practical necessity if progress is to be made. This is an opposite reflection of Robbins' rejection of the behaviourist claim that science should only deal with phenomena that are observable, as economics must deal with subjective values that are *understandable*, but not *observable*. Thus, the case for an empirical approach to studying entrepreneurship is related to the fact that the nature of entrepreneurship is more *observable* than it is *understandable*.

A second reason for utilising an empirical approach is related to the common view that that entrepreneurship is an integral component of the KBE and is extensively associated with economic growth, regional resilience, and adaptability. Thus, policy makers are becoming increasingly interested in entrepreneurship as an empirical phenomenon on a spatial level. What is particularly useful from a policy perspective is explaining the determinants of entrepreneurship i.e. what causes some regions to be more entrepreneurial than others and thus display greater levels of economic growth/greater resilience and adaptability over time. Furthermore, 'predictive adequacy and explanatory power' are important aspects of empirical theories that enable grounds for choice between competing perspectives (Caldwell, 1982). In order to add to this 'predicative adequacy and explanatory power', it is necessary to test theories utilising different techniques on relevant, recent data. This thesis will achieve this by utilising newly available Business Demography statistics regarding firm formation in Great Britain (GB), as well as employing a range of spatial econometric techniques to control for spatial spillovers; this particular aspect has been overlooked in much past econometric work attempting to explain spatial variations in entrepreneurship.

With the above considerations in mind, a research design employing a quantitative methodology, emphasising an empirical epistemological position embedded within a positivist paradigm, will be utilised in this thesis to meet research objectives. This approach typically involves several attitudes and approaches that are desirable for economists: value neutrality, objectivism, and determinism (Sarantakos, 2005). The value neutrality and objectivism of the positivist paradigm ensures that economic principles are separated from cognitive and political biases and, consequently, the resulting subjective moral standpoints of those conducting research. Any paradigm that has a deterministic outlook on human behaviour implies that people "follow strict causal laws and that if these laws are discovered social life can be predicted and controlled" (Sarantakos, 2005:34). This is undoubtedly the position of the economist, who seeks to uncover the causal laws behind human decision making. Positivism emphasises the role of causality, and both the KSTE and human capital/entrepreneurial ability approach posit causal factors behind entrepreneurship. In the former, opportunities for profit resulting from the innovative research activity of incumbent firms that are left unappropriated, due to the nature of uncertainty surrounding knowledge, results in a stock of entrepreneurial opportunities for nascent entrepreneurs to appropriate; in this sense, investment in knowledge *causes* entrepreneurship through the provision of opportunity. With regards to the latter, it is suggested that the increased cognitive abilities of individuals, resulting from their education and experience, provides them with the capacity to behave in a more entrepreneurial fashion by being better able to recognise opportunities for profit; in this sense, education and experience *cause* people to behave entrepreneurially. Thus, there are several advantages to employing a quantitative, empirical approach to the study of entrepreneurship in a KSTE and entrepreneurial ability context.

However, as with any methodological position, there are potential shortcomings in utilising such an empirical approach to entrepreneurship based within a positivist paradigm. For example, the use of firm births as an observable manifestation of entrepreneurship means that entrepreneurship is effectively being analysed indirectly and this may not fully capture all form of entrepreneurial behaviour. Whilst Coase (1937) and

Audretsch and Keilbach (2004a; 2004c) emphasise that entrepreneurship manifests itself in the creation of organisations and the creation of firms, a potential problem concerns how much entrepreneurial behaviour is missed with this approach. For example, many of the examples of entrepreneurial behaviour Shultz (1975; 1980) provides do not involve the creation of an organisation but concern more obscure changes in behaviour, such as relocating time between competing uses. However, for most purposes relevant to the KSTE and the aggregated spatial approach to entrepreneurial ability to be considered in this thesis, the creation of firms is the most useful metric of entrepreneurial behaviour in these contexts. Using firm births to quantify entrepreneurship also has relevance on the basis that whilst some entrepreneurial behaviour might not manifest itself in the creation of a firm, it can still be said that the creation of an organisation must necessarily encapsulate entrepreneurial behaviour. Furthermore, previous research utilising firm births to approximate entrepreneurial behaviour provides empirical validation of the measure, on the basis that utilising firm births to measure entrepreneurship supports the predictions of theory, particularly with regards to the KSTE and its impact on economic performance (Audretsch, Bönte and Keilbach, 2008; Audretsch and Keilbach, 2004b; 2007; 2008a). Thus, a quantitative methodology utilising firm births to measure entrepreneurial behaviour is a suitable approach to the study of entrepreneurship.

Another potential shortcoming with the quantitative empirical approach being taken, as well as positivism in general, is that the assumption that entrepreneurial opportunities exist as an objective reality over looks other epistemological positions. Other approaches to entrepreneurial research, such as those which employ a constructivist methodology (Bouchikhi, 1993; Wood and McKinley, 2010), suggest that entrepreneurial opportunities do not exist as an objective reality, but are instead constructed by potential entrepreneurs through consensus building amongst peers. These approaches can find some application in the work of Schumpeter and Knight; Schumpeter, for example, discusses the entrepreneur constructing a future in the image of himself for the joy of creating (Swedberg, 2007); similarly, Knight's treatment of uncertainty and it is pervasiveness throughout reality enables man to construct a future shaped by the ideology and values they possess (Gordon, 1974). These insights might suggest that entrepreneurial opportunities are so much discovered, by constructed and appropriated according to the entrepreneurs will. It is important to remember that no epistemological or methodological position is infallible and the selection of an appropriate epistemological and methodological position should be based on the needs of the research agenda. The fruitfulness of previous research, particularly the existing empirical results of the KSTE that treats entrepreneurial opportunities as existing objectively, validates this approach. Accordingly, the objective existence of entrepreneurial opportunities will be assumed throughout this thesis and analysed as such with appropriate econometric methods. These have the causal relationship 'built in', by utilising an appropriate measure of entrepreneurship as a dependent variable in a regression model, to be explained through a matrix of explanatory variables.

5.3 – Methods

In order to analyse the relationship between knowledge and entrepreneurship within a KSTE and human capital/entrepreneurial ability context, a mixture of Exploratory Spatial Data Analysis (ESDA) and spatial econometric techniques will be utilised. When conducting statistical analyses of this nature using spatial data it is important to consider the level of geography being used, as results can sometimes differ due to the Modifiable Areal Unit Problem (MAUP). This is the phenomenon where the "results of statistical analysis are not independent of the scale at which the analysis is done" (Flowerdew, 2011; Openshaw, 1984; Openshaw and Taylor, 1979). This can manifest itself in the 'Scale Problem', whereby statistics might be very different depending on the scale size of the geography used (e.g. Output Area, Ward or District), or the 'Zonation Effect', where the "results of statistical analysis are dependent of the configuration of the zonal systems used" (Flowerdew, 2011). Past research has shown that the potential effects of the MAUP are somewhat ambiguous; for example, Openshaw (1984) and Openshaw and Rao (1995) have shown that a whole range of correlation coefficients between two variables are possible depending on the geography used, whereas Flowerdew (2011) finds, using 2011 UK census data, that the problem does not produce serious differences in the majority of cases. Nonetheless, it is important to remember that the results of the econometric analysis to come could differ depending on the geographical unit of observation and it is the 'Zonation Problem' that is particularly relevant to this thesis.

One of the more common geographical constructs used in spatial data analysis, particularly in KSTE research, is an administrative region such as German *Kreise* (Audretsch and Keilbach, 2008) or UK Local Authority Districts (LADs) (Bishop, 2012). Alternatively, Travel to Work Areas (TTWAs) are based on economic activity across an area, providing a geographical construct that represents a 'self-contained' labour market, "one in which all commuting occurs within the boundary of the area" and produced using commuter flows from Census of the Population data (Carrington, Rahman and Ralphs, 2007). A TTWA is defined such that "at least 75% of the area's resident workforce work in the area and at least 75% of the people who work in the area also live in the area" (Carrington, Rahman and Ralphs, 2007). Thus, they provide an economically relevant geographical construct and may serve to lessen spatial autocorrelation issues within the data that can occur due to spatial dependence or spatial heterogeneity. TTWAs have several advantages, in that they are designed specifically for labour markets and for an economic purpose, provide a statistically consistent geography for the whole country, and provide a link between workplace and home. However, TTWAs have been criticised precisely because they cut across some administrative boundaries and, as currently available TTWAs are based on 2001 census data, are slightly dated (Carrington, Rahman and Ralphs, 2007). Furthermore, some areas have been deemed 'too big to be useful'; for example, London is considered as one large TTWA and this might overlook the fact that the boroughs and districts that constitute Greater London are very diverse in terms of both demographics and industry.

With these criticisms in mind, LADs based on the 2008 boundaries will be utilised, as they have a number of advantages in comparison to TTWAs. Beyond their precedence in KSTE related research (e.g. Bishop, 2012), the newly available Business Demography statistics use LADs as its sub-regional breakdown and their common use provides a wide array of readily available data for use in an econometric analysis. Whilst Bishop (2012: 654) indicates that the administrative boundaries of LADs are not meaningful economic constructs and can result in spatial autocorrelation issues, the consequences of this will be discussed in greater detail later.

First, a detailed ESDA analysis of the spatial distribution of firm births across the 408 pre-2009 LADs of Great Britain (GB) between 2008 and 2010 will be conducted in Chapter 6. The data for these years, as well as all subsequent data in the ESDA and spatial econometric analysis to come, will be converted into cross sectional data set by taking the average values of each variable for each of the LAD over the relevant time period. This cross sectional approach is necessary as the data on firm births to be used, the newly available Business Demography statistics from the Office of National Statistics (ONS), have only been compiled from 2008 onwards, and are thus lacking an adequate number of observations for a temporal analysis. Furthermore, using cross-sectional data in this way also helps alleviate any short term fluctuations in the data that might affect the regression estimates.

ESDA techniques are particularly useful on new data, as this approach examines data without any preconceived ideas, theories, or hypotheses (Bishop, 2011). ESDA involves "summarising spatial properties of the data, detecting spatial patterns in the data, formulating hypotheses which refer to the geography of the data, [and] identifying cases or subsets of cases that are unusual given their location on the map" (Haining, 2003). Given that these data will be utilised as a dependent variable in a series of regressions in the coming chapters, identifying extreme values and sub-sets of cases that are unusual is particularly pertinent, as they may have an influence on the regression results. Thus another purpose of this ESDA is to assess the suitability of this variable as a dependent variable in a linear, spatial regression context. The ESDA will involve the computation of descriptive statistics, quartile maps, and spatial autocorrelation statistics in the form of Moran's *I* for global spatial autocorrelation and local indicators of spatial autocorrelation

(LISA) statistics that identify spatial clustering and spatial outliers, useful for a descriptive exposition of potential patterns and relationships.

Firm birth counts are considered 'extensive' spatial data and are 'often inappropriate for a spatial analysis, as they tend to be correlated with some metric of region size, such as geographical area or regional population (Anselin, 2004). In order for this firm birth data to be suitable for an ESDA and a dependent variable in a spatial regression analysis, it needs to be transformed into an 'intensive' variable, by calculating a density or rate; this will be achieved by dividing the count of regional firm births by the regional population of working age (19-64). Thus, from here on the regional firm birth rate will be referred to when discussing regional entrepreneurship.

Following this, a spatial econometric analysis of the KSTE and the relationship between human capital and entrepreneurship will be conducted in Chapters 7 and 8 respectively. This analysis will involve a number of linear regression models using the regional firm birth rate as a dependent variable. This will be regressed against a matrix of explanatory variables regarding the KSTE, human capital, and diversity, with a number of control variables whose inclusion is motivated by the literature; a brief ESDA and descriptive analysis of each explanatory variable will be performed in each chapter where relevant. OLS estimation will be used for the non-spatial linear regression models, assessing the various marginal effects of the explanatory variables, followed by several tests on the residuals from the model to determine heteroskedastic and spatial autocorrelation issues. Lagrange Multiplier (LM) tests will be computed to test for spatial dependence issues (Anselin, 1988b), which will be controlled for using spatial lag and spatial error models. The spatial lag and spatial error models will be estimated using a combination of Generalised Method of Moments (GMM) and Maximum Likelihood (ML) estimation procedures. Different spatial weights, based contiguity and distance, will be used to determine the extent to which these spatial issues persist. Should heteroskedasticity issues be present in the computation of these models, as indicated by the diagnostic testing, adjusted standard errors will be used.

In the absence of spatial effects, the relationship between the explanatory variables and entrepreneurship takes the following standard linear functional form:

$$y_i = \alpha + \beta X_{ki} + \varepsilon$$

Where y_i is the dependent variable representing entrepreneurship, in this case regional firm birth rates, X_i is a matrix of observations of k explanatory variables, ε is a vector of independently and identically distributed (i.i.d.) error terms, and α and β are the parameters to be estimated, where α is a constant and β_i is the marginal effect of x_i on the dependent y_i for region *i*. The assumption of i.i.d. error terms is a standard assumption with linear multiple regression analysis (Hill, Griffiths and Lim, 2012), and one that is often violated by the presence of spatial autocorrelation within spatial data. Spatial autocorrelation stems from the fact that the units of observation in a spatial analysis, a particular level of geography, are not always completely independent from spatial units in close proximity. As such, linear regression models that do not control for this issue can result in error terms that are not identically distributed and correlate with errors from neighbouring regions. Spatial autocorrelation can occur due to the presence of two types of spatial effects: spatial dependence and spatial heterogeneity (Anselin, 1988a). It is necessary to control for spatial autocorrelation, as failing to do so can lead to bias estimates and increases the potential for erroneous inferences based on the OLS linear regression results. Both spatial dependence and spatial heterogeneity can be controlled for through the application of spatial econometric methods once it is determined, through spatial autocorrelation tests on the residuals from linear regression models, which of these two spatial effects exist within the data (Anselin and Rey, 1991; Bishop, 2012).

Spatial dependence refers to the "existence of a functional relationship between what happens at one point in space and what happens elsewhere" (Anselin 1988). This could be caused by either one of two broad classes of reasons, the first being as a "by-product of measurement errors for observations in contiguous spatial units" (Anselin 1988). This can occur as a result of the spatial unit of observation having arbitrarily defined boundaries and is particularly relevant to our analysis here due to the use of LADs as the appropriate spatial unit. The second relates to the “importance of space as an element in structuring explanations of human behaviour” (Anselin and Rey, 2009) and is of particular interest to spatial interaction theories in regional science and human geography. These two issues can lead to spatial dependence caused by different kinds of spatial spill-over effects (Anselin, 1988b).

Spatial dependence is controlled for using a spatial lag model, which takes the general functional form:

$$y_i = \alpha + pW_{ij}y_i + \beta X_i + \varepsilon$$

Where y_i, X_i, α, β and ε are as before. $W\,y$ is a spatially lagged dependent variable y for the spatial weights matrix W and p is a parameter to be estimated. In terms of the spatial weights matrices to be used in the forthcoming analysis, W_{ij}, takes the value 1 if regions i and j are considered neighbours, 0 otherwise.

Spatial heterogeneity refers to the “lack of uniformity of the effects [of variables] across space” caused by a “lack of structural stability” and that “spatial unit[s] of observation [are] far from homogeneous” (Anselin, 1988a); this spatial heterogeneity may result in heteroskedasticity if it is reflected in the measurement errors, causing the standard issues associated with a non-constant error variance. This heteroskedasticity can “easily result from the heterogeneity inherent in the delineation of spatial units and from contextual variation over space” (Anselin, 1988b).

Spatial heterogeneity is controlled through the specification of a spatial error model, which takes the general functional form:

$$y_i = \alpha + \beta X_i + \varepsilon, \qquad with\ \varepsilon = \lambda W_{ij}\varepsilon + u$$

Where y_i, X_i, α, β and W_{ij} are as before. In this second set of models, ε is a vector of spatially autocorrelated error terms, u is a vector of i.i.d. errors and λ is a parameter to be estimated (Anselin, 2004). Identifying the presence of either spatial dependence or spatial heterogeneity and specifying the preferable spatial model is determined through spatial diagnostic testing. Lagrange Multiplier (LM) and Robust LM tests are computed on the residuals from the non-spatially weighted OLS models and the significance of the test statistics indicates the appropriate spatial models to use (Anselin, 2004).

Of central importance to the spatial econometric process is how to define which regions are to be considered as neighbours. Two different approaches will be utilised in the analysis, defining neighbours based on contiguity and also on distance. Contiguity based spatial weights come in two specifications, based on the Rook criterion, where any regions that share a common border are deemed neighbours, and the Queen criterion, where any regions that share *any* point in common i.e. a common border and/or a common corner[3] are deemed neighbours (Anselin, 2004). The 'order of contiguity' of these spatial weights must then be decided, with order of 1 referring to the immediate neighbours, order of 2 including neighbours of neighbours etc., such that with an increasingly large order of contiguity, an increasingly large area is considered as neighbouring the region in question. An alternative approach is to designate regions as neighbours using a spatial weights matrix based on distance and distance based spatial weights also come in two forms. First, they can be specified according to a 'threshold distance', where regions are specified as neighbours if their 'centroids', or central points corresponding to "the average of the x and y coordinates in the polygon boundary" (Anselin, 2004), fall within a given Euclidian distance of one another. Second, regions can be specified as neighbours depending on their distance to one another relative to their distance from other regions, for example through specifying the four nearest regions to the central region as neighbours.

For the ESDA, only spatial weights based on the Queens criterion at a contiguity of order 1 (QCO1) will be used, mainly for simplicity and to maintain a reasonable volume of output. The spatial regression models will utilise a variety of spatial weights to test how different considerations of space can influence the regression results. Four different spatial weights based on contiguity and distance will be used: contiguous spatial weights based on

[3] "The number of neighbours for any given spatial unit according to the queen criterion will be equal to or greater than that using the rook criterion" (Anselin, 2004)

the Queens criterion at a contiguity of order 1 (QCO1) and of order 2 (QCO2), as well as 4 nearest neighbours (4NN) and 8 nearest neighbours (8NN).

In order to compute the ESDA, OLS linear regressions, spatial weights, spatial statistics, and spatial models, OpenGeoDa and GeoDaSpace spatial modelling software will be used. These programmes are freely available from the 'GeoDa Center for Geospatial Analysis and Computation' in affiliation with Arizona State University (GeoDa-Center, 2014). There are some limitations in the software relating to their abilities to compute certain models with non-symmetric spatial weights and the computation of heteroskedasticity consistent standard errors with certain spatial specifications. Specific limitations will be mentioned in the empirical analysis where relevant and both modelling programmes will be used to various degrees in order to minimise the impact of these limitations on the regression results.

One potential shortcoming with the time period being analysed is that it covers, almost in its entirety, a recession from beginning to end and this might have the effect of distorting longer term trends. This might have particular relevance on a spatial level, on the basis that certain regions may enter and exit a recession at different time relative to other regions (Campos*, et al.*, 2011; Parkinson, Meegan and Karecha, 2014). For example, Campos *et al.* (2011: 3) found that "unemployment levels were adversely affected by the recession at different times in each area". In particular, they find that the "West Midlands and the North West saw the largest rises in the unemployment rate… during the course of the recession. However, these areas then began to see falls in the unemployment rate before others" (Campos, *et al.*, 2011: 3). Similarly, Parkinson, Meegan and Karecha (2014) show that the performance of UK regions, in terms of changes in GVA per capita, varied significantly during the recession. For example, Wales experienced a 3.4% growth in GVA per capita between 2008 and 2011, whereas the East of England stagnated, achieving only 0.1% growth in GVA per capita over the same period; these figures can be compared to the UK national average of 1.8% growth in GVA per capita between 2008 and 2011. These unemployment and GVA per capita figures serve to illustrate how the negative effects of the recession can affect different regions at different times with varying degrees of severity.

However, there are two reasons why these issues might not be too severe in the context of the econometric analysis of entrepreneurship to be conducted in this thesis. First, the fact that the data from each year will be averaged to form a cross section might alleviate some of the temporal variation caused by the recessionary period. Second, regional entrepreneurial activity is typically observed to be a time persistent phenomenon that is not greatly distorted over time and has a "stable regional distribution" (Andersson and Koster, 2011: 195), due to path dependent processes and spatially 'sticky' determinants (Andersson and Koster, 2011; Fotopoulos, 2014; Martin and Sunley, 2006) i.e. spatial variations in entrepreneurial activity are fairly stable over the business cycle. Thus, it is anticipated that the recent recession will have a relatively small influence on spatial variations in entrepreneurial activity over the time period being analysed here. However, the recession may have a larger effect on the trends of explanatory variables and this should be considered when placing the econometric results into a wider context.

5.4 – Data Sources

Audretsch and Keilbach (2004a; 2004c) state that entrepreneurship manifests itself in a singular way; the start-up of a new firm, making firm birth rates the most logical choice for a dependent variable in any econometric analysis of entrepreneurship. Firm birth rates are commonly used as a measure of regional entrepreneurship (Audretsch and Keilbach, 2007), and to measure regional 'entrepreneurship capital' when linking entrepreneurship and regional growth (Audretsch, Bönte and Keilbach, 2008; Audretsch and Keilbach, 2004a; 2004b; 2008a). However, whilst firm birth rates are a common choice for measuring entrepreneurship, there are alternatives measures used to approximate entrepreneurial behaviour that have been used in previous research and these need to be briefly examined. These have generally taken two forms; the proportion of a given population that are registered as business owners or self-employed and the numbers of new firms that meet a given tax registration threshold over a specified time period.

For example, Thurik (2003) utilises the rate of non-agricultural, incorporated, and non-incorporated business ownership as a percentage of the labour force as a measure of entrepreneurship when analysing the relationship between unemployment and entrepreneurship from a cross-national perspective. A similar method to the use of business ownership rates that has precedence in existing literature is the utilisation of self-employment rates as an approximation of a population's proclivity towards entrepreneurship (Acs*, et al.*, 2009; Barth, Yago and Zeidman, 2006; de Wit, 1993; Evans and Jovanovic, 1989; Evans and Leighton, 1989; Stewart and Roth, 2001). A closely related variable that is also prominent in empirical literature is the Total Entrepreneurial Activity (TEA) measure developed by the Global Entrepreneurship Monitor (GEM). The GEM seeks to establish trends in entrepreneurship across countries and assemble harmonized data to facilitate cross-country analysis through a variety of qualitative research methods (Reynolds*, et al.*, 2005). The TEA is an index created for each country that takes the percentage of adults aged 18-64 setting up a business or owning a young firm that is less than 42 months old. Small business ownership rates are thus an important part of this statistic, although only for young businesses (Reynolds*, et al.*, 2005). Several empirical studies utilise the TEA for use as a dependent variable when seeking to explain cross country variations in entrepreneurship (Stel, Carree and Thurik, 2005; Wong, Ho and Autio, 2005). The use of business ownership or self-employment rates in these studies can partly be attributed to the availability of data, as these are perhaps the only suitable measures that are available for use in models using cross-country data. This is indicative of the difficulty in conducting empirical work across varying contexts.

Using the number of firms registering for Value Added Tax (VAT) purposes over a specified time period as a proxy measure of entrepreneurship also has precedence in the literature, particularly when analysing UK data (Anyadike-Danes and Hart, 2006; Bishop, 2012); every new registration acts a proxy for a firm birth. As of 2014, a UK business is currently[4] required to register for VAT purposes "if your turnover of VAT taxable goods and services supplied within the UK for the previous 12 months is more than the current

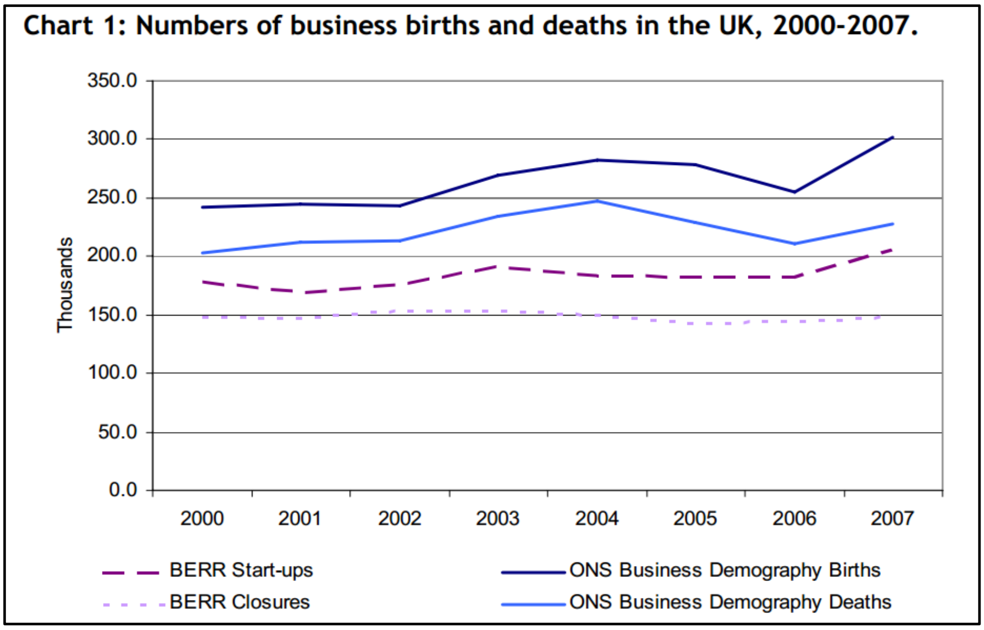
[4] This is correct at the time of writing (April 2014) but is subject to change on an annual basis

registration threshold of £81,000" (HMRC, 2014). Issues with the use of VAT registrations to proxy for entrepreneurship are related to the fact that it can be distorted by other factors; for example, the reason for a new registration can be attributed to the purchase of a non-registered firm by a new proprietor or as a result of firm growth where turnover begins to exceed the threshold. This is a cause for concern for Johnson and Conway (1997), who question the use of VAT registration data as a proxy for firm formation and provide evidence of the fairly significant distortion caused by firm growth and the time delay observed between a firm beginning trading and registering for VAT. However, this issue is mitigated somewhat if the time series observations are converted into a cross-section, as in Bishop (2012).

The sole use of new registrations for VAT as a proxy for firm formation has been phased out in the UK as part of an EU wide initiative to provide consistent national data on firm births and deaths. 'VAT registrations and de-registrations' data, compiled by the Department for Business, Enterprise and Regulatory Reform (BERR) (BERR, 2007) ceased to be compiled from 2008 and has been replaced by the 'Business Demography: Enterprise Births and Deaths' publication by the Office of National Statistics (ONS) (ONS, 2008). This new approach takes into account firms that are PAYE-registered in addition to those who are registered for VAT, providing statistics on a sub-regional level. A firm birth occurs when a firm is registered for PAYE and/or VAT in year 't' but not in year 't-1' or 't-2'. Conversely, a death is said to have occurred where a firm is registered for PAYE and/or VAT in year 't', but not in year 't+1' or 't+2'. The ONS show that the inclusion of PAYE registered firms increases the number of firm births and deaths when compared with VAT registrations only and the data can therefore be considered more comprehensive (Figure 5.1). The difference between the ONS Business Demography statistics and the BERR statistics can be quite pronounced; in terms of firm birth rates as a proportion of active enterprises in 2007 the ONS Business Demography statistics suggests a rate of 13.1%, compared to a 10.1% rate in the BERR data (Figure 5.2) (ONS 2008). Little empirical analysis of the 'Business Demography' publications has been conducted thus far, largely due to its recent release, and this thesis provides an excellent opportunity for research into regional variations in entrepreneurship across the UK based on these new, more complete data.

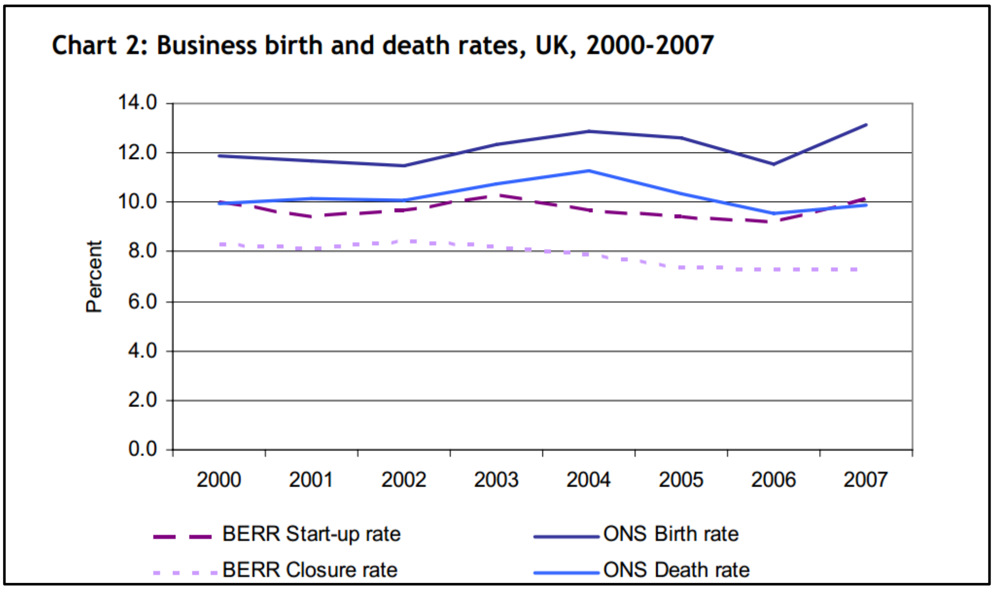
In terms of the explanatory variables, data were gathered from a variety of sources, including the ONS, NOMIS (labour market statistics from the ONS), the UK Intellectual Property Office (UKIPO), and EUROSTAT, the official statistical authority of the European Union. The data cover the 408 pre-2009 LADs of GB for the years 2008-2010 and will be converted into a cross-sectional format by averaging the values for both the dependent and independent variables for each LAD for reasons discussed earlier. For brevity and due to the structure of the empirical analysis to follow, the precise explanatory variables and the source of the data used to calculate these explanatory variables will be made explicit in the relevant chapters when they are discussed in more detail.

Figure 5.1. Historical comparison of UK business births and deaths (Business Demography) with VAT registrations and de-registrations (BERR), 2000-2007.



Source: ONS (2008)

Figure 5.2. Historical comparison of UK business birth and death rates (as a proportion of stock, Business Demography) with VAT registration and de-registration rates (as a proportion of stock, BERR), 2000-2007.



Source: ONS (2008)

5.5 – Conclusion

The purpose of this chapter was to discuss epistemological and methodological issues relating to the empirical study of entrepreneurship, as well as providing an overview of the spatial econometric methods and data to be used in the forthcoming empirical analysis. Section 5.2 argued that empiricism forms an integral part of the epistemological position of economic science and may also have particular relevance to the study of entrepreneurship from an economics perspective. Sections 5.3 and 5.4 discussed the various spatial econometric methods and data with which this thesis will seek to provide a comprehensive empirical investigation of entrepreneurship within the KBE, with a particular focus on the KSTE and human capital approaches to entrepreneurship.

The remainder of this thesis will proceed as follows. Chapter 6 will provide a detailed ESDA of the dependent variable in the forthcoming spatial econometric analysis; firm birth rates of the 408 pre-2009 LADs of GB from 2008-2010. Chapter 7 will investigate the empirical evidence for the KSTE, analysing its predictive adequacy and explanatory power using newly available GB data and utilising a series of variables related to the creation of entrepreneurial opportunities through the production of knowledge; this chapter has an emphasis on the nature of opportunity creation in the KBE. Chapter 8 will investigate the relationship between human capital, entrepreneurial ability, and entrepreneurship through a variety of spatial models utilising various demographic based variables and a similar range of control variables. This chapter arguably encapsulates a more traditional approach to entrepreneurship by having a dominant focus on the cognitive attributes of the individual, looking at what 'causes' the recognition and exploitation of entrepreneurial opportunities. Both of these chapters will utilise a variety of spatial weights in the spatial modelling procedures to analyse the potential different spatial dynamics of the different forms in which knowledge exists i.e. its explicit/codified and tacit/embodied forms. Chapter 9 will conclude the thesis, broadly assessing the empirical findings and discussing some policy implications from the results.

6

Chapter 6 – Firm Births in Great Britain: 2008-2010

6.1 – Introduction

The purpose of this chapter is to conduct an ESDA on a cross section of Business Demography data on firm births based on the pre-2009 LADs across GB from the years 2008-2010. These data were the latest available at the onset of the research. ESDA involves "summarising spatial properties of the data, detecting spatial patterns in the data, formulating hypotheses which refer to the geography of the data, [and] identifying cases or subsets of cases that are unusual given their location on the map" (Haining, 2003). Given that these data will be utilised as a dependent variable in a series of regressions in the coming chapters, identifying extreme values and sub-sets of cases that are unusual is particularly pertinent, as they may have an influence on the regression results; thus, another purpose of this chapter is to assess the suitability of this variable as a dependent variable in a linear, spatial regression context. This will be achieved first by analysing the data from a global and regional perspective through a range of descriptive statistics and spatial inequality measures, and second through an analysis of spatial autocorrelation statistics at both a global and local level.

6.2 – Descriptive Statistics and Spatial Inequality

The spatial units of observation in this analysis are the pre-2009 LAD's across GB, and, as with all spatial data, it is necessary to distinguish between spatially extensive and spatially intensive variables. Spatially extensive variables are quantities or counts whereby their variation is dependent primarily on the size of the region to which they refer, in terms of area or population for example. Thus, it is necessary to analyse rates, proportions, or densities through the use of a suitable denominator; these are termed spatially intensive variables (Haining, 2003). With regards to entrepreneurship, there are typically two commonly used denominators, based on the active business stock or the regional labour force; the choice between the two is of some importance due to the fact that there is typically little correlation between the two measures (Bishop, 2012). Using the stock of active enterprises as the denominator implicitly views new firms emerging from existing businesses, and is perhaps particularly relevant in a Schumpeterian context; however, this approach effectively precludes those who are economically inactive and not working in a current business (Bishop, 2012). The second approach, utilising the local labour force as the denominator, takes the view that those who start businesses are typically members of the regional labour force. This approach can be said to have theoretical appeal as it is based on theories of occupational choice, such as Evans and Jovanovic (1989), in which individuals choose to become entrepreneurs on the net benefits compared to other labour market choices. The labour market approach will be taken here, partly due to its theoretical appeal, and partly due to its precedence in the KSTE related literature (Audretsch, Dohse and Niebuhr, 2010; Audretsch and Keilbach, 2007; Bishop, 2012). Whether the ESDA and regression results would substantially differ through the use of the stock of active enterprises as the denominator is an interesting point of departure and perhaps worthy of further research.

Entrepreneurship is defined as firm births per 1000 (FB1000) of the working population across LADs in GB between 2008 and 2010. This can be formally stated as:

$$Firm\ Birth\ Rate = \frac{Firm\ Births_i}{Count\ of\ Resident\ Population\ aged\ 16-64_i} \times 1000$$

Where i is a given sub-regional observation. Table 6.1 displays the mean (μ), standard deviation (σ) and coefficient of variation (*CV*)[5], which normalises σ by μ, at a global level and at the old Government Office Region[6] (GOR) level.

Table 6.1. Descriptive statistics of firm birth rates across GB, 2008-2010 (National and by Government Office Region (GOR))

	μ	σ	*CV*
National	**6.22**	**9.98**	**1.61**
National Excl. City of London	**6.17**	**2.33**	**0.38**
East GOR	6.54	1.69	0.26
East Midlands GOR	5.32	1.12	0.21
Inner London	13.05	52.90	4.05
North East GOR	4.03	0.97	0.24
North West GOR	5.55	1.28	0.23
Outer London	8.02	1.73	0.22
Scotland	4.55	0.88	0.19
South East GOR	7.02	1.86	0.27
South West GOR	5.73	1.02	0.18
Wales	4.40	0.86	0.20
West Midlands GOR	5.47	1.23	0.22
Yorkshire and the Humber GOR	5.09	1.41	0.28

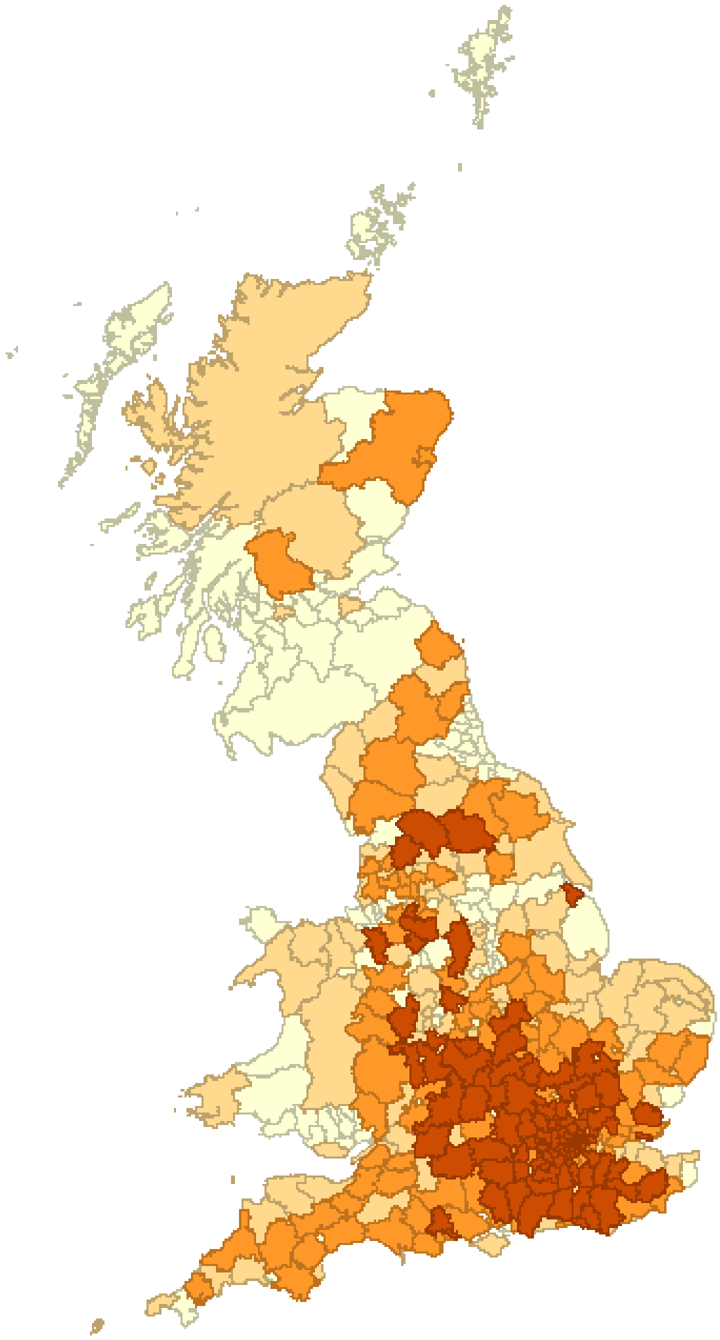
From a global perspective, it can be seen that, between 2008 and 2010, there were on average[7] 6.22 firm births per 1000 people of working age. Due to the City of London (CoL) LAD being a significant outlier with over 202 firm births per 1000 of the resident population, the national μ, σ, and *CV* were computed with this observation excluded, as extreme values can have a large effect on the mean based measures of dispersion such as σ. With the CoL excluded, this figure falls only slightly to a mean of 6.17 firm births per 1000 people; however, excluding the CoL has a significant impact on the σ and *CV*. In terms of the regional statistics, what is immediately clear is that London (Inner and Outer) and the South East GOR appear significantly more entrepreneurial than the rest

[5] The CV is defined as $\frac{\sigma}{\mu}$, the standard deviation normalised by the mean. This allows a comparison of dispersion across different regions that have different means.
[6] GORs no longer exist, but the concept has been retained for the construction of regional statistics
[7] The mean was computed through aggregating the numerator and denominator separately, a process that is necessary with spatially intensive variables (Haining 2003: 51) that was also applied to each of the regional statistics.

of England, where as the more peripheral regions of the North East GOR, Scotland, and Wales seem to perform considerably poorly in comparison. What this tentatively seems to suggest is that as the distance from London increases, the entrepreneurial tendency of the population tends to decrease. This trend can be seen visually in the quartile map of Figure 6.1.

The data suggest that London is the most entrepreneurial region in GB and this is perhaps expected. Considered a truly ‘global city’(Sassen, 2001), it is home to a large number of industries and services that are particularly conducive to entrepreneurial activity and, as it is also integrated with the global economy to a greater extent than any other city in GB, this makes it a particularly attractive place to start a business. Furthermore, a significant number of people commute from outside of London in order to work in businesses there. This may accentuate the observed differences between London and the rest of GB due to the greater number of business relative to the resident population. That the South and South East of England also exhibit greater than average firm birth rates is perhaps a manifestation of Tobler’s (1970) first law of geography, “everything is related to everything else, but near things are more related than distant things”; it is reasonable to suggest that both of these regions benefit greatly, in terms of entrepreneurial activity, from their proximity to London. There also appears to be a number of prominent areas covering sub-regions that belong in the lowest quartile of firm birth rates: Glasgow and South West Scotland, Cardiff, Newport and Swansea across southern Wales, the North East of England, and an area around the M62 in Yorkshire. The quartile map of Figure 6.1 is indicative of the possible presence of several clusters of sub-regions that exhibit high and low firm birth rates; the LISA analysis of Section 6.3 will examine whether these clusters are statistically significant. Finally, the *CV*s suggest that dispersion within each of the regions are fairly similar, with the exception of Inner London that appears to exhibit a fairly pronounced spatial inequality in firm birth rates across its composite sub-regions, undoubtedly due to the influence of the CoL.

Figure 6.1. Quartile map depicting the distribution of mean firm birth rates across GB from 2008-2010. The darkest shaded regions are LADs that belong in the uppermost quartile of firm birth rates, whereas the lightest shaded regions are LADs belonging to the bottom quartile.



The σ and *CV* are two widely used measures of dispersion that are used in the literature; however, different measures of dispersion can reveal different conclusions and hence two further inequality measures, Theil Index (*T*) and Gini Coefficient (*G*), will be used to illustrate the robustness of this spatial inequality. T is a member of the entropy class of inequality measures, a set of inequality measures that meet a set of "five commonly accepted axioms" concerning the nature of inequality (Bishop, 2011; Cowell, 2011). T is formally defined as:

$$T = \frac{1}{n}\sum_{j}\frac{I_j}{\bar{\bar{I}}}ln\left(\frac{I_j}{\bar{\bar{I}}}\right)$$

Where n is the size of the sample, here the 408 LADs of GB, I represents the firm birth rate for sub-region j, and $\bar{\text{I}}$ is the mean firm birth rate. The value of *T* varies from 0, representing maximum equality i.e. each sub-region exhibiting the same firm birth rate, to $\ln(n)$, representing maximum spatial inequality i.e. all of the firm births in one sub-region. *G*, whilst not being a member of the generalised entropy class of indices, is also a commonly employed measure of inequality and is formally defined as:

$$G = \frac{1}{2n^2\bar{\bar{I}}}\sum_{j}\sum_{k}\left|I_j - I_k\right|$$

Where n, I, $\bar{\bar{I}}$ are as before, whilst j and k refer to regions j and k respectively. *G* varies from 0, representing maximum equality, to 1, representing maximum inequality. Thus, as inequality increases, *T* and *G* also increase. Table 6.2 shows both T and G at a global level, global level excluding the CoL, and regional level. Again, it can be seen that spatial inequality is fairly similar within each region. Furthermore, it appears that T is much more sensitive to extreme outliers than G in this context, as it exhibits a much larger proportional drop when the CoL is excluded.

Table 6.2. Global and regional inequality statistics.

	T	*G*
National	**0.241**	**0.236**
National Excl. City of London	**0.057**	**0.176**
East GOR	0.030	0.141
East Midlands GOR	0.019	0.112
Inner London	0.873	0.634
North East GOR	0.022	0.124
North West GOR	0.024	0.121
Outer London	0.022	0.125
Scotland	0.018	0.111
South East GOR	0.032	0.145
South West GOR	0.015	0.096
Wales	0.018	0.108
West Midlands GOR	0.020	0.115
Yorkshire and the Humber GOR	0.027	0.134

One of the benefits of using *T* is that it can be decomposed into intuitively appealing components without a residual, with the goal of assessing "the extent to which total inequality is affected by inequality within individual regions as compared with inequality between regions" (Bishop, 2011). Formally, if there are *g* regions, *T* can be decomposed as:

$$T = \sum_{g} p_g \mu_g T_g + \sum_{g} p_g \mu_g ln(\mu_g)$$

Where p_g, μ_g, and T_g are the population share, mean firm birth rate relative to the national mean, and the *T* index for region g; the first term refers to within region (intra-regional) inequality, whereas the second term refers to between region (inter-regional) inequality. Table 6.3 shows this decomposition with two different sets of component groups; the upper decomposition in Table 6.3 uses the old GORs as the component groups, again with London split into Inner and Outer London, whilst the lower decomposition uses London (both Inner and Outer) and the rest of GB as the two component groups, as well as these calculations with the CoL excluded altogether. With the CoL included and using GORs as the relevant constituent groups, it can be seen that the intra-regional component dominates but only slightly; with London and the rest of GB as the constituent groups, the influence of intra-regional inequality is more pronounced. When the CoL is excluded, the intra-inequality component of *T* falls in relation to the inter-regional component and accounts for 52% of total inequality. In general, excluding the CoL does not appear to have too much of an effect on the decomposed components of *T*.

Table 6.3. Decomposition of *T* Index using GORs, London, and GB as constituent groups

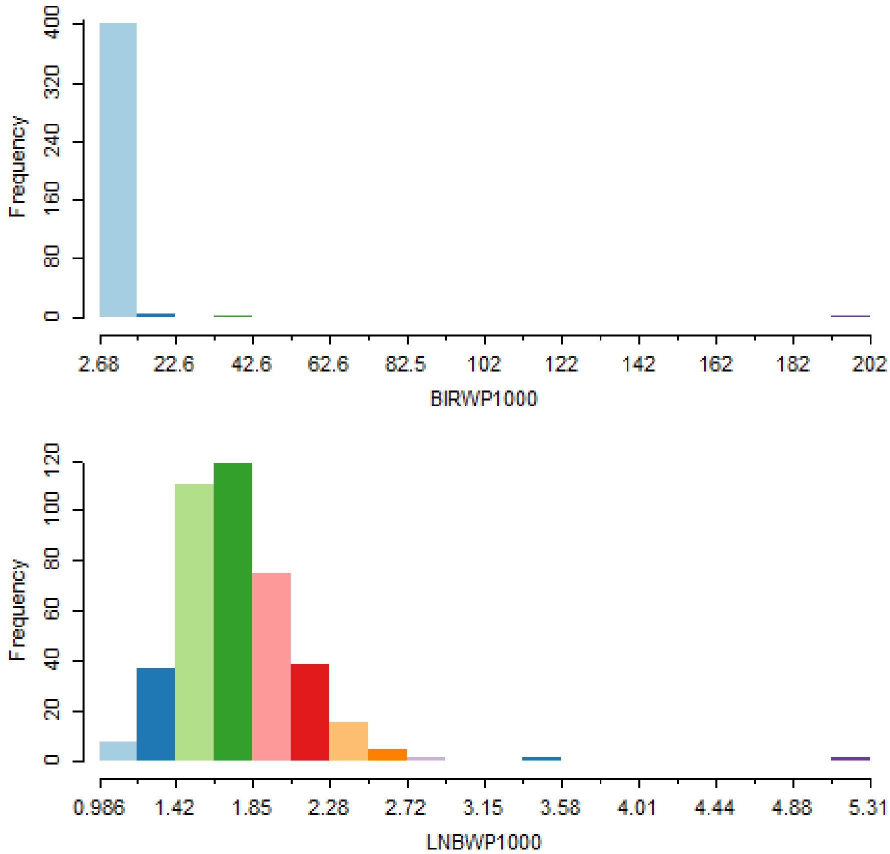
	T	Intra-regional	Inter-regional	Percentage intra-regional
GORs	0.241	0.138	0.103	0.572
LDN vs GB	0.241	0.180	0.061	0.747
GORs excl. CoL	0.057	0.030	0.028	0.520
LND excl. CoL vs GB	0.057	0.044	0.013	0.775

Two important conclusions emerge from these descriptive statistics. The first relates to the higher entrepreneurial tendency of London and the surrounding regions, as indicated by their higher than average firm birth rates; the reasons behind this will be the focus of the coming chapters. Secondly, and perhaps most importantly as far as the regression analysis is concerned, the CoL and perhaps London generally can be seen to have a significant impact on the measures of dispersion (σ and *CV*) and the measures of spatial inequality (*T* and *G*). Extreme outliers can have a serious impact on both the estimated coefficients of regression models and the residuals, such that it might be necessary to control for the effect of the CoL specifically through the use of an indicator variable as an explanatory variable[8], signifying 1 for the CoL observation and 0 otherwise. This will control the residual from this observation but does not, however, account for the impact of the skewed distribution as a whole, which can be seen visually by the upper histogram of Figure 6.2 (showing firm births per 1000). It might therefore also be necessary to use a logarithmic transformation of the firm birth rate variable in order for its distribution to be more symmetric and better resemble a normal distribution, thus being more suitable as a dependent variable in linear spatial regression analysis, a method also followed by

[8] It is sometimes common practice to exclude extreme outliers from regression analyses completely, however the spatial nature of this analysis precludes this option as it would leave a spatial 'hole' in the dataset. Including a dummy variable for CoL is equivalent to excluding the observation.

Bishop (2012). The natural log transformation of the firm birth rate variable can also be seen in the bottom histogram of Figure 6.2, which can still be seen to have a positive skew; however, this is much less apparent than the skew of the untransformed firm birth rate.

Figure 6.2. Histograms depicting the distribution of firm birth rates per 1000 (FB1000) (top) and the natural log transform of this variable (LNFB1000) (bottom)



6.3 – Spatial Autocorrelation and Local Clusters

Having described some basic patterns in the spatial distribution of firm birth rates, the analysis now turns to examine more sophisticated measures of spatial association through the computation of global spatial autocorrelation with Moran's *I* and the decomposition of this through local indicators of spatial autocorrelation (LISA) (Anselin, 1995). Spatial autocorrelation is broadly defined as "the phenomenon where locational similarity (observations in spatial proximity) is matched by value similarity" (Anselin, 1999).

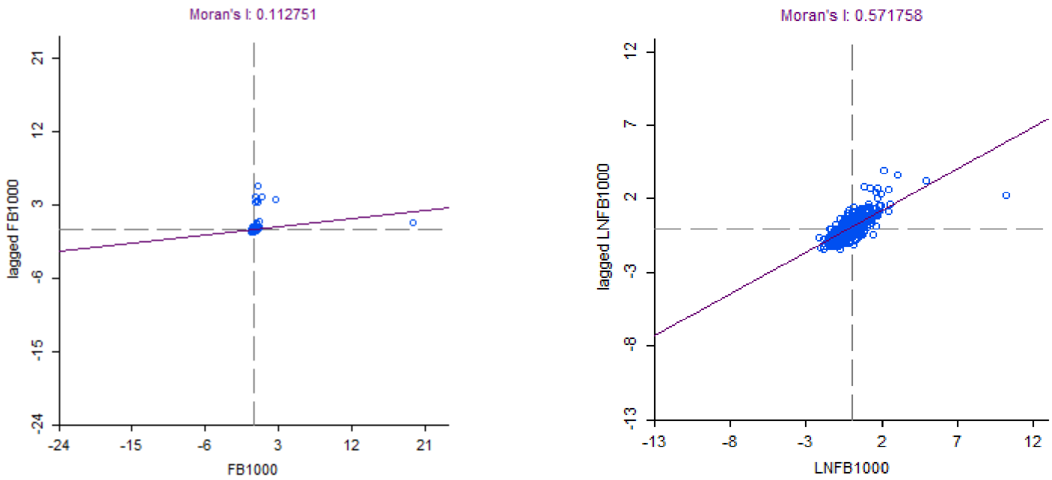
Global indicators, such as Moran's *I*, summarise the degree of spatial dependence into one indicator, with the obvious limitation that this may mask more interesting incidences of spatial dependence at a local level. It also has the drawback of assuming spatial stationarity, with a constant mean and constant variance that precludes the occurrence of either spatial drift or spatial outliers (Anselin, 1999). These two assumptions are certainly misleading from the perspective of investigating entrepreneurship on a spatial level across GB, particularly with regards to the prevalence of entrepreneurial activity in London as indicated by the descriptive statistics in the previous section. Accordingly, one of the main aspects of ESDA lies in "visualising local patterns of spatial association, indicating local non-stationarity and discovering islands of spatial heterogeneity" with LISA statistics (Anselin, 1999). These LISA statistics may in fact be 'in line' with the global indicators, however it is possible that "the local pattern is an aberration that the global indicator would not pick up" (Anselin, 1995:97). Exploring LISA statistics is perhaps the more revealing of the two approaches, as the presence of spatial heterogeneity in the form of local clusters may indicate the presence of entrepreneurial spatial regimes, similar to those described by Audretsch and Fritsch (2002). Thus, this section will predominantly focus on local level spatial dependence and the identification of spatial clusters and outliers. An essential aspect of this analysis is the specification of a suitable spatial weights matrix, discussed in the last chapter and which expresses the spatial arrangement of the data (Anselin, 1999). There are several that can be chosen that might be appropriate, but this analysis will utilise a spatial weights matrix based on the Queens criterion with a contiguity of order 1 (QCO1). This specifies a region as a neighbour to another if they share any common boundary; neighbours are allocated a one in the spatial weights matrix and zero otherwise.

The global indicator of spatial autocorrelation, Moran's *I*, is defined as:

$$I = \left(\frac{n}{s}\right)\frac{\sum_i \sum_j w_{ij} z_i z_j}{\sum_i z_i^2}$$

Where n is the number of observations, z_i is the deviation of the variable, in this case the firm birth rate, from the mean, w_{ij} is the weight (in the case of QCO1, this equals one if the regions are contiguous, and zero otherwise), and s = $\sum_i \sum_j w_{ij}$. These statistics are commonly displayed as a Moran scatterplot, which shows the spatial lag of firm birth rates for each region on the vertical axis, and the firm birth rate at each location on the horizontal axis (Anselin, 1999). Furthermore, the use and visualisation of the Moran statistic in this way follows from the interpretation of the Moran's *I* statistic as a regression coefficient in a bivariate spatial lag scatter plot, such that it corresponds to the slope of the regression line through the points (Anselin, 1999). The Moran's *I* statistics and scatterplots for both FB1000 and LNFB1000 can be seen in Figure 3 below.

Figure 6.3. Moran scatterplot depicting the global spatial autocorrelation in FB1000 (left) and LNFB1000 (right).



The left-hand scatterplot of FB1000 reveals a Moran's *I* statistic of 0.113 and shows what appears to be a weak positive spatial autocorrelation. Despite this apparently weak association, *I* is statistically significant at a 0.001 pseudo-significance level[9]. This statistic, as well as the scatterplot, is undoubtedly heavily skewed by the presence of the CoL as an extreme outlier, and hence the Moran statistics and scatterplot of LNFB1000 should interest us more on a global level; FB1000 is included here mainly for completeness. With regards to LNFB1000, it can be seen that the log transform of firm birth rates exhibits a fairly strong positive spatial autocorrelation with an associated *I*

[9] It should be noted that the significant tests against the null hypothesis of no spatial autocorrelation are conducted using a permutation procedure, whereby a reference distribution is generated from random layouts with the same data values as those observed (Anselin 2003; Bishop 2011). 999 permutations are used in all of the significance testing of the Moran's *I* and LISA statistics.

statistic of 0.572, which is again significant at a 0.001 pseudo-significance level. Thus, it can be concluded that entrepreneurship shows a certain degree of positive spatial autocorrelation, in that regions in close proximity to one another are likely to be similarly entrepreneurial, at least on average from a global perspective.

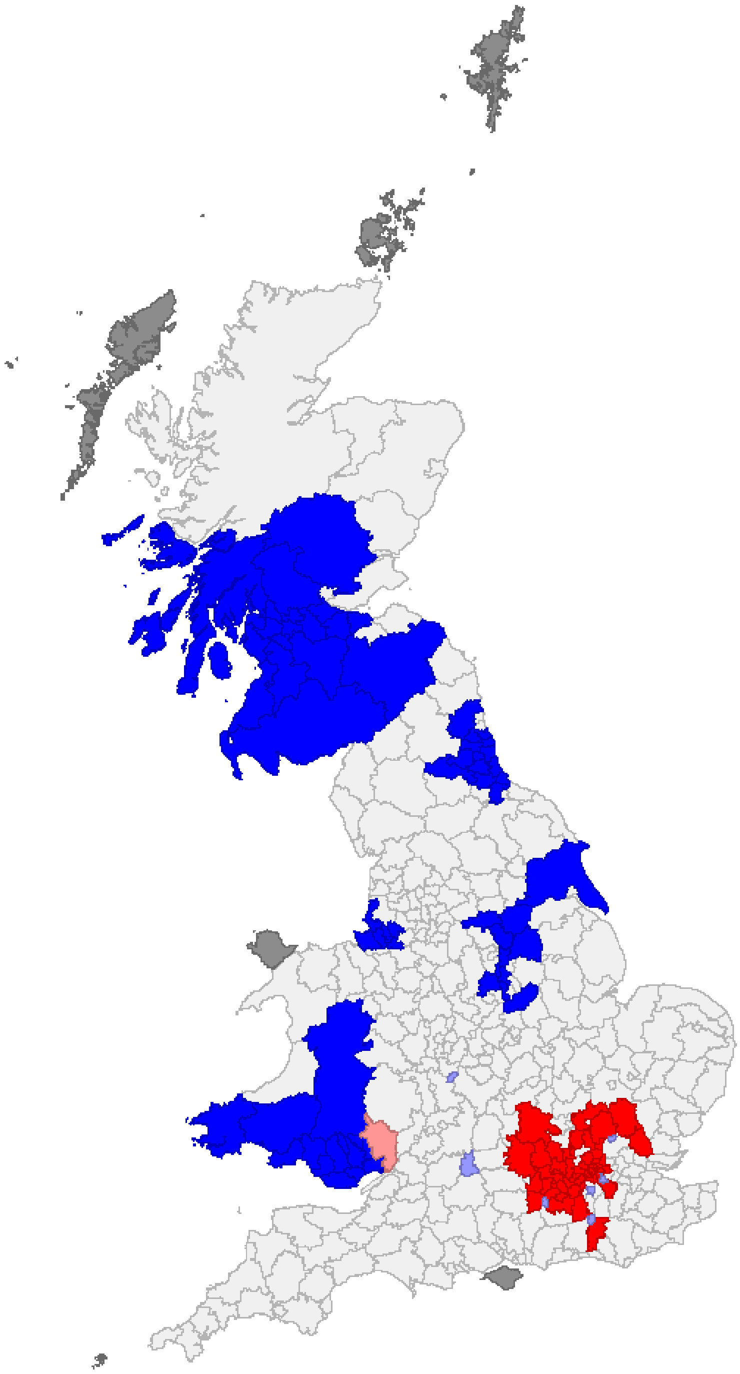
The decomposition of *I* into local components can be defined for the *i*th location as:

$$I_i = z_i \sum_i w_{ij} z_j$$

Where z_i and w_{ij} are as before, and the observations are standardised with a mean of 0 and a variance of 1. LISA stats are computed for every location, measuring the extent of spatial clustering of similar values of a variable. For example, positive local autocorrelation will be present if regions exhibiting relatively high firm birth rates neighbour regions with similarly high firm birth rates (Anselin, 2004; Bishop, 2011). This enables the identification of both spatial clusters, regions where the values are similar across space (i.e. high-high, low-low), and spatial outliers, where values are dissimilar given the values of neighbouring regions (i.e. low-high, high-low) (Bishop, 2011). This can result in a large output, and as such LISA statistics are most efficiently presented in the form of LISA maps, as seen in Figures 6.4 and 6.5.

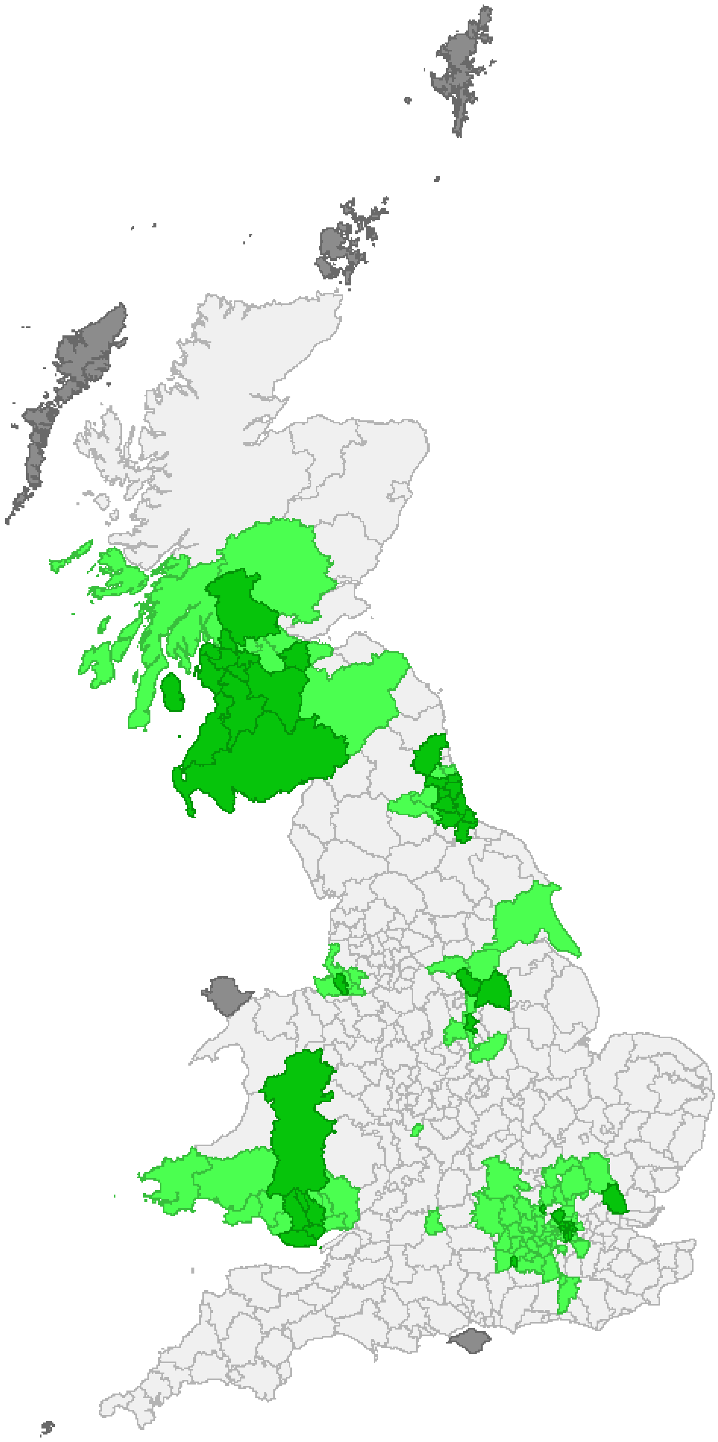
In terms of spatial clusters of regions with high firm birth rates, the cluster comprising Greater London and parts of the surrounding area extending into the East and South East is the only example of a statistically significant cluster of regions across GB with high firm birth rates. That Greater London can be considered a significant cluster of sub-regions with high firm birth rates isn't particularly surprising, as this reaffirms the patterns seen in the earlier descriptive statistics. The reasons why London is so entrepreneurial will form the subject matter of the coming chapters; however London's entrepreneurial vigour in relation to the rest of GB could be explained by its institutional and industrial structure. London is home to a significant financial services sector, numerous venture capitalist firms, international institutions, and a highly qualified labour force (Sassen, 2001). Saxenian (1990, cited in Audretsch and Fritsch, 2002) provides insight into how these forms of local

Figure 6.4. LISA cluster map of FB1000[10]. The shaded areas represent the 'core' of the cluster, implying that the cluster may also extend to neighbouring regions as well. Blue shaded areas signify significant clusters of low entrepreneurial activity, where the red shaded areas represent clusters of high entrepreneurial activity. Pink and purple shaded areas show the spatial outliers. Dark grey shaded areas represent 'neighbourless' regions.



[10] Due to the nature of LISA statistics, extreme outliers in the distribution will only affect their immediate neighbours. Therefore, the CoL doesn't affect any of the other main clusters across GB, such that the FB1000 and LNFB1000 cluster maps had little difference between them, besides the fact that the London 'high-high' cluster was slightly larger and the North East/Scotland 'low-low' cluster was slightly smaller in the LNFB1000 maps.

Figure 6.5. LISA Significance map of FB1000[11]. All of the regions that constitute a part of a cluster are statistically significant at a 95% pseudo-significance level. The darker shaded areas show regions that are statistically significant at a 99% pseudo-significance level.



[11] It should be noted that as the pseudo-significance levels are computed through a permutation procedure, there can be changes in the significance of the marginally significant/insignificant regions i.e. computing the LISA maps again may show slight changes in the clusters. However, the inference of the presence of certain clusters is unaffected, as they remain consistent regardless of the amount of permutations conducted.

institutions, organisations, and networks can be conducive to local entrepreneurial culture in the context of Silicon Valley and the entrepreneurial growth regimes posited by Audretsch and Fritsch (2002):

> "A variety of regional institutions – including Stanford University, several trade associations, and local business organisations, and a myriad of specialised consulting, market research, public relations and venture capital firms – provide technical, financial, and networking services which the region's enterprises often cannot afford individually. These networks defy sectoral barriers [and] this decentralised and fluid environment also promotes the diffusion of intangible technological capabilities and understandings." (Saxenian 1990, cited in Audretsch and Fritsch 2002)

London also exhibits similar institutional tendencies in respect to the rest of Great Britain, particularly with regards to the provision of financial services. Historically, London has been prominent commercial and financial centre, through the development of institutions such as the Bank of England, London Stock Exchange, and Lloyds of London dating back to the seventeenth century (City of London Corporation, 2014a). As of 2014, approximately one third of all financial services employment in Great Britain is located within Greater London (City of London Corporation, 2014b). Clearly, the integration of this financial services sector with other commercial institutions may be a source of the dynamic increasing returns that fosters the development of the time persistent entrepreneurial culture posited by Fritsch and Wyrwich (2012), placing London at an entrepreneurial advantage relative to the rest of Great Britain. The surrounding areas of the East and South East immediately adjacent to London generally exhibit higher firm birth rates in relation to the rest of Great Britain, and are perhaps an example of how agglomerative effects can spillover from major urban centres into the surrounding areas.

Conversely, there are five prominent areas that perform poorly and comprise statistically significant clusters of regions that exhibit low firm birth rates, those being South West Scotland, Southern Wales, North East England, a cluster of regions encompassing Yorkshire, Derbyshire and Nottinghamshire and a smaller cluster in the North West of England surrounding Liverpool. The clusters in Southern Scotland and Southern Wales cover a wide area, a large proportion of which is rural, however they do contain major urban centres such as Cardiff, Swansea, Glasgow, Edinburgh, whilst the other clusters include the conurbations of Liverpool, Barnsley, Doncaster and Rotherham. In terms of the clusters they comprise parts of, many appear to encapsulate areas in close proximity to major British coalfields and have historically exhibited a greater than average employment in coal mining and related activities (Beatty, Fothergill and Powell, 2005). 'Old industries' that were heavily dependent on coal, such as steel and metal processing, centred their production in these areas, as it provided the resources and means for expansion (Birch, MacKinnon and Cumbers, 2010). Accordingly, these regions became heavily industrialised during the industrial revolution and beyond; in fact, the clusters exhibiting low entrepreneurial activity identified as statistically significant correspond to a large extent with regions that Birch, MacKinnon and Cumbers (2010) refer to as 'old industrial regions' (OIRs).

There are perhaps two related approaches that might explain why there appears to be a spatial association between clusters of regions with low entrepreneurial activity and OIRs; the first relating to path dependent processes that foster the development of a persistent local entrepreneurial culture, and the second relating to the spatially 'sticky', time persistent 'explanatory' factors. With regards to the first, Fritsch and Wyrwich (2012) describe an entrepreneurial culture as encapsulating an "aggregate psychological trait" (Freytag and Thurik, 2007, cited in Fritsch and Wyrwich, 2012) exhibited by a regional population that leaves them oriented towards entrepreneurial values, such as "individualism, independence, and achievement" (Fritsch and Wyrwich, 2012). An important aspect of this is the concept of spatial variation in the social acceptance of entrepreneurship, that according to North (1994) is a form of informal institution that changes "only gradually over time" (Fritsch and Wyrwich, 2012). Institutional hysteresis, the "tendency for formal and informal institutions, social arrangements, and cultural norms to be self-reproducing through time", is one of three sources of 'path dependence' (Martin and Sunley, 2006). David (2007) describes path dependency as a "dynamic process whose evolution is governed by its own history", thus creating a 'historical narrative' within which current behaviour is framed. It is a probabilistic and contingent process, whereby the occurrence of certain past behaviour makes that same behaviour more likely to occur in the future (Martin and Sunley, 2006).

Fritsch and Wyrwich (2012) argue that entrepreneurial activity is characterised as a path dependent process on a regional level, as local entrepreneurial culture is a persistent phenomenon. In this context, it might be reasonable to suggest that the past regional characteristics of OIRS could negatively impact entrepreneurial activity through the lack of entrepreneurial culture. The centring of industries dependent on coal, such as metal processing and ship building, can be characterised by large production plants with significant scale economies and a highly unionised labour force (Birch, MacKinnon and Cumbers, 2010). This might naturally have led to the development of institutions and organisations that reflected this industrial structure, which may also additionally influence the cultural and social tendencies of the local labour force. Such social institutions and organisations, particularly the unionised labour force, are likely to be resistant to processes of change and the reorganisation of the means of production, two fundamental manifestations of the entrepreneurial process. This could result in the lack of a local entrepreneurial culture that would persist over time based on concepts of path dependence and regional 'lock-in' (Martin and Sunley, 2006). This is in contrast to the more service industry oriented south and south east, a significantly higher proportion of which is more likely to be owned through self-employment and small firms (Massey, 1984); this is more likely to provide a conducive environment through the complementary development of appropriate institutional, organisational, cultural and social structures. This is reflected through the significant clusters of 'high-high' regions in London and the South East.

Andersson and Koster (2011) argue that attributing the persistence in the spatial variation of entrepreneurial activity purely down to path dependent processes, involving slowly evolving institutions, social acceptance, and cultural norms, that fosters a self-reproducing entrepreneurial culture is perhaps an oversimplification. Instead, they also emphasise the simultaneous impact of 'sticky regional characteristics', the concept that "many of the factors that influence start-up activities are fixed in time and fit within the concept of a slowly changing production milieu" (Andersson and Koster, 2011:182). From the perspective of 'sticky determinants' of entrepreneurship, these regions have arguably experienced the effects of deindustrialisation to a greater extent than other parts of Great Britain, a process that is still on-going (Birch, MacKinnon and Cumbers, 2010). For example, Birch, MacKinnon and Cumbers (2010) provide evidence that employment growth in British OIRS has stayed, on average, persistently lower than the national average between 1996 and 2002, exacerbated by a greater than national average fall in manufacturing employment. Unemployment is consistently considered as an explanatory variable in econometric models looking to explain spatial variations in entrepreneurship (Audretsch, Dohse and Niebuhr, 2010; Audretsch and Keilbach, 2007; Bishop, 2012) and it is generally found that local unemployment has a negative impact on entrepreneurship; however, the nature of the relationship is argued to be theoretically ambiguous depending on whether the research is cross sectional or has a temporal component (Evans and Leighton, 1989). Beatty, Fothergill and Powell (2005) suggest that these regions haven't quite recovered from the large and immediate coal job losses that occurred between 1985 and 1995, where nearly 90% of the 221,000 jobs in the coal mining industry were lost throughout Britain. Consequently, this has resulted in significant structural deficiencies, creating higher local unemployment and those claiming incapacity benefit relative to the rest of GB (Beatty, Fothergill and Powell, 2005) and 'deep intra-regional socio-spatial inequality' (in terms of incomes, wealth, health, and living conditions) (Hudson, 2005:582), that perhaps makes these regions less desirable in which to conduct business and start a firm. Hudson (2005), with particular reference to the North East, found that such 'profoundly deindustrialised regions' find themselves "on the margins of the global economy… disconnected from the decisive circuits of capital and the major growth mechanisms of the contemporary capitalist economy" (Hudson, 2005:581-582). Entrepreneurship has consistently been seen as a 'major growth mechanism' in the contemporary economy (Audretsch, Keilbach and Lehmann, 2006), and the statistically significant clusters of sub-regions with low levels of entrepreneurial activity is perhaps reflective of the disconnection of these regions from the ‘circuits of capital’ and ‘major growth mechanisms’ of the KBE.

6.4 – Conclusion

The general conclusion that can be drawn from this brief ESDA of firm birth rates in GB from 2008-2010 is that entrepreneurial activity varies significantly across space. Some regions, mainly those centred on London and the south of England, exhibit far greater firm birth rates than others; the more peripheral regions of the North East of England, Scotland and Wales appear to lag somewhat behind the rest of GB, at least in terms of entrepreneurial activity. The inequality statistics seem to suggest a fairly consistent pattern of spatial inequality, both within regions and between them. It can also be seen that the raw firm birth rate (FB1000) exhibits a very severe positive skew due to the presence of the City of London as an extreme outlier; in the regression analyses of the coming chapters, it will be necessary to utilise a logarithmic transformation of the firm birth rate (LNFB1000) for it to be more suitable as a dependent variable. From a spatial autocorrelation perspective, entrepreneurship appears to show a significant positive spatial autocorrelation, providing further evidence that entrepreneurial activity is not randomly distributed across space. Thus, there is a significant degree of value similarity and locational similarity, both at a global level and, perhaps more importantly, at a local level. The LISA statistics provide compelling evidence of the presence of spatial regimes across GB. In particular, London and the surrounding regions of the South East appear to exhibit what might be considered an ‘entrepreneurial regime’, whereas there are several prominent areas exhibiting low levels of entrepreneurial activity, perhaps associated with the characteristics of OIRs and the concept of local entrepreneurial culture.

The nature of how these regimes persist over time, as well as their impact on other economic indicators such as economic and employment growth is perhaps worthy of further investigation and a fruitful area for future research. However, existing research suggests that the patterns observed in the ESDA presented here are likely to be representative of long term patterns and trends in regional entrepreneurship. For example, using UK VAT registration data between 1994 and 2007, Fotopoulos (2014) finds that “interregional differences in new firm formation and their determinants are time persistent”. Similarly, Fritsch and Mueller (2007) show, using German data, that “there are great differences between regional start-up rates” and that the inter-regional differences in entrepreneurial activity “shows a pronounced degree of persistence and path-dependency over time” (Fritsch and Mueller, 2007: 311). Of particular relevance to the analysis of this chapter, Fritsch and Mueller (2007) also argue that the ‘entrepreneurial climate’, or ‘entrepreneurial culture’, is a significant determinant of inter-regional differences in entrepreneurial activity. Moreover, it has been argued by the same author (Fritsch and Wyrwich, 2012) that entrepreneurial culture also shows remarkably long persistence, which supports the concept that OIRs lack an adequate entrepreneurial culture in light of their heavily industrialised past. The argument presented here of the association between OIRs and entrepreneurial activity is sufficiently compelling that it may be instructive to control for the effect of OIRs directly as an explanatory indicator variable. This may adequately control for the lack of an adequate local entrepreneurial culture, which might otherwise be embodied in the residuals of the models and which would thus exhibit spatial dependence, potentially violating a key assumption of OLS linear regression.

7

Chapter 7 – The Knowledge Spillover Theory of Entrepreneurship: A Spatial Analysis of Great Britain 2008-2010

7.1 – Introduction

The empirical analysis begins with an examination of the main principles of the KSTE, discussed extensively in Chapter 4, Section 4.4. The KSTE posits that, due to the uncertainty regarding the value of knowledge as an input (Arrow, 1962b), firms are unlikely to fully appropriate the returns from their innovation. This contributes to a gap between new knowledge and economic knowledge, termed the 'knowledge filter', as a proportion of knowledge that is created will be left un-commercialised by incumbent firms. This creates an opportunity for an individual who is privy to this knowledge to appropriate its potential returns through the creation of a new firm and represents an 'intra-temporal' knowledge spillover (Acs*, et al.*, 2009; Audretsch and Keilbach, 2007; 2008a; 2008b; Audretsch and Lehmann, 2005). Based on this work, several statistically testable hypotheses can be derived in the form of the *Endogenous Entrepreneurship Hypothesis* (Audretsch and Keilbach, 2008b), *Localisation Hypothesis* (Audretsch and Keilbach, 2008b), and *Barriers to Entrepreneurship Hypothesis* (Acs*, et al.*, 2009). Furthermore, the KSTE suggests that intra-temporal knowledge spill-overs are 'spatially bounded', as firm births are invariably located in close proximity to the incumbent firm, due to the advantages associated with local networks and markets, as well as the costs of relocation (Audretsch and Lehmann, 2005). Consequently, the KSTE moves away from traditional entrepreneurship research that is primarily focused on the cognitive process by which entrepreneurs discover opportunities (Audretsch and Keilbach, 2007). The KSTE manages this by considering entrepreneurial opportunity as being endogenously created and the entrepreneur as exogenous.

The purpose of this chapter is to empirically investigate the main tenets of the KSTE through the application of spatial econometric techniques on newly available Business Demography data concerning the 408 pre-2008 LAD's of GB between 2008 and 2010, and utilising a number of original explanatory variables. In doing so, this will address a number of issues within previous empirical work, relating to the variables used and spatial autocorrelation issues that can occur within spatial data, whilst also gaining greater insight into the effects of the myriad of variables that can influence entrepreneurship.

7.2 – Empirical Model

As discussed in greater detail in Chapter 5, a number of linear regression models will be specified using the log of regional firm births per 1000 of the regional population of working age (hereafter LNFB1000) as the dependent variable. This will be regressed against explanatory variables denoting regional knowledge, regional industrial diversity, and a series of controls. OLS estimation will be used for the non-spatial linear regression models, assessing the various marginal effects of the explanatory variables, followed by several tests on the residuals from the models to determine specification and spatial autocorrelation issues. Lagrange Multiplier (LM) tests will be computed to test for the presence of spatial dependence, which will be controlled for using a spatial lag model, or for the presence of spatial heterogeneity, which will be corrected for using spatial error models. Different spatial weights, based on varying levels of contiguity and distance, will be used to determine the extent to which these spatial issues persist over space. Should specification issues be present after the computation of these models, as indicated by the diagnostic testing, adjusted standard errors will be used. The OLS linear regressions, spatial lag, and spatial error models will be of the following general functional forms:

OLS Linear Estimation

$$y_i = \alpha + \beta X_{ki} + \varepsilon$$

Where y_i is the dependent variable, a log transformation of the firm birth rate for region *i*, X_i is a matrix of observations of k explanatory variables relating to regional knowledge stocks and a selection of control variables, ε is a vector of independently and identically distributed (i.i.d.) error terms, and α and β are the parameters to be estimated, where α is a constant and β_i is the marginal effect of x_i on the dependent y_i for region *i*.

Spatial Lag Estimation

$$y_i = \alpha + pW_{ij}y_i + \beta X_i + \varepsilon$$

Where y_i, X_i, α, β and ε are as before. *W y* is a spatially lagged dependent variable *y* for the spatial weights matrix *W* and *p* is a parameter to be estimated. The spatial weights matrix, shown by W_{ij}, denotes whether regions are considered neighbours and can take various forms; both contiguity based spatial weights, based on the Queens criterion of order 1 (QCO1) and order 2 (QCO2), and distanced based spatial weights, based on the 4 nearest neighbours (4NN) and 8 nearest neighbours (8NN) principles, will be utilised (Anselin, 2004).

Spatial Error Estimation

$$y_i = \alpha + \beta X_i + \varepsilon, \qquad with\ \varepsilon = \lambda W_{ij}\varepsilon + u$$

Where y_i, X_i, α, β and W_{ij} are as before. In this alternative set of models, ε is a vector of spatially autocorrelated error terms, u is a vector of i.i.d. errors and λ is a parameter to be estimated (Anselin, 2004).

7.3 – Measurement and Descriptive Analysis of Explanatory Variables

7.3.1 – Knowledge Outputs

As has been noted in previous chapters, ascertaining what constitutes 'knowledge' and then attempting to measure it a meaningful way is a rather difficult task. Arrow (1962b) discusses at great length issues surrounding allocating property rights around knowledge, highlighting the 'obvious' and 'enormous' difficulty in "defining in any sharp way an item of information and differentiating it from similar sounding items" (Arrow, 1962b). Griliches (1979) affirms this by suggesting that the "results of research and development are by and large not directly observable". Of course, if the relationship between knowledge and entrepreneurship is to be statistically tested, this obstacle must be overcome by quantifying some output from, or input to, the knowledge generating process; both of these approaches will be utilised here.

Developing a meaningful measure of knowledge output is perhaps the biggest challenge faced in this area of research. A common knowledge output used in empirical KSTE research is related to patent intensity, typically the number of patents registered in a region per 1000 of the labour force (AVPAT) (Acs*, et al.*, 2009; Audretsch, Bönte and Keilbach, 2008; Usai, 2010). The number of patents can be considered a particularly useful explanatory variable as not only does it give some measure of regional knowledge-based innovation, it also highlights the importance of securing intellectual property rights to the entrepreneurial process. Patents can be considered as an output in this regard as they typically represent some aspect of knowledge that an organisation or individual deems sufficiently valuable to enter a process to secure property rights. Spatial contexts that produce more knowledge can reasonably be assumed to also apply for property rights contingent on that knowledge to a greater degree, thus implying that the amount of regional knowledge produced and regional patent intensity are positively related. However, the theoretical relationship between regional patent intensity and regional entrepreneurship is perhaps somewhat ambiguous. Acs*, et al.* (2009) argue that a "higher proportion implies that incumbents use more of the existing knowledge flows"; conversely, Audretsch, Bönte and Keilbach (2008) argue that "regional innovation efforts have a positive impact on regional knowledge based entrepreneurial activity", partly through the indirect effect of increasing the stock of technical knowledge. Both predictions were borne out in their respective empirical results. The different results might be attributed to a fundamental methodological difference between the two, in that Acs*, et al.* (2009) use country level panel data. This temporal component to their research might be crucial in a similar way to how the effect of unemployment on entrepreneurship can differ between cross-sectional and time series data (Evans and Leighton, 1989).

To calculate regional patent intensity, the number of patents registered in a region in 2009 and 2010 was identified using data from the UK Intellectual Property Office (UKIPO). Unfortunately, there were many missing addresses in the 2008 data and this year was consequently excluded from the analysis. Use of this variable was made possible by the fact that every patent application has a personal or commercial registration address; the postcodes of every patent were then cross-referenced with the corresponding LAD. Due to the theoretical appeal of linking increased patent intensity with increased knowledge output, and given that the data to be used here will be a cross-section, it is hypothesised that a positive relationship will be observed between regional patent intensity and firm births. Analysis of the spatial distribution of regional patent intensities (Appendix: A1) shows that regions located in the south, particularly those located between London and Bristol in the South West, appear to have a greater endowment of regional knowledge. This is in line with Usai (2010) who found a similar geographical pattern in UK patenting activity, albeit at a higher level of geography. The histogram depicting the distribution of AVPAT (Appendix: A2, top) suggests the presence of a severe positive skew, exacerbated by the CoL and its unusual population demographics. The extremity of the CoL LAD as an outlier might bias the estimated coefficient and, accordingly, a logarithmic transformation of the AVPAT variable (LNAVPAT) will also be used to test the sensitivity of the estimate; a histogram of this transformed variable, LNAVPAT, can also be found in the Appendix (A2, bottom). Both of these variables will be used in separate models for completeness.

The second knowledge output considered in the KSTE literature relates to university knowledge output, measured through the number of academic publications associated with a particular university (Audretsch and Lehmann, 2005). The methodological approach utilised by Audretsch and Lehmann (2005) differs somewhat from other KSTE research, as they attempt to associate the tendency of firms to locate within a proximate distance of universities throughout Germany. That innovative knowledge might be spatially ‘located’ nearby universities is logically consistent and, as an interesting aside, three of the more ‘patent intense’ regions across GB are associated with Cambridge University (Cambridge and South Cambridgeshire) and University College London (Westminster). To approximate the knowledge output of German universities, Audretsch and Lehmann (2005) utilise student numbers and an aggregation of university publications as explanatory variables. The main premise here is that the greater number of students attending and research papers published by a university, the more knowledge intensive the university and, by extension, the more knowledge intensive the region that is home to the university can be said to be. Audretsch and Lehmann (2005) find that the number of students and the number of research publications has a positive effect on the number of regional technology start-ups located in close proximity to the university; furthermore, the effect of these variables is seen to vary depending on sector. However, there are several issues with this approach. The positive influence of the number of university students on technology start-ups based might measure the effect that universities have on educating the local labour force, which could then have a positive effect on local entrepreneurship. However, this does make the assumption that university graduates would look to remain local to the university they attended; these issues will be discussed in greater detail in the coming chapter. Furthermore, despite the fact that journal publication volume indicates some measure of knowledge output at a university, it is unclear whether journal publications would be a good indicator of ‘spatially bounded’ knowledge; this is due to the fact that journal publications are typically electronic and therefore ‘a-spatial’. To avoid these issues, the econometric analysis presented here will utilise a simpler measure of the effect of universities on knowledge spillover entrepreneurship, through constructing a binary indicator variable specifying whether a particular LAD is associated with a higher education institution. Each university will be attributed an appropriate LAD through individually collecting postcodes from the main address of each institution and cross referencing them with LADs using NOMIS software from the ONS. When an institution has multiple campuses and there is no clear 'main' campus, LADs associated with each campus will also be indicated with a 1; this was, however, only relevant with less than 10% of the universities throughout GB. It is expected that the presence of a university will have positive influence on knowledge spillover entrepreneurship, under the premise that these regions will produce more knowledge.

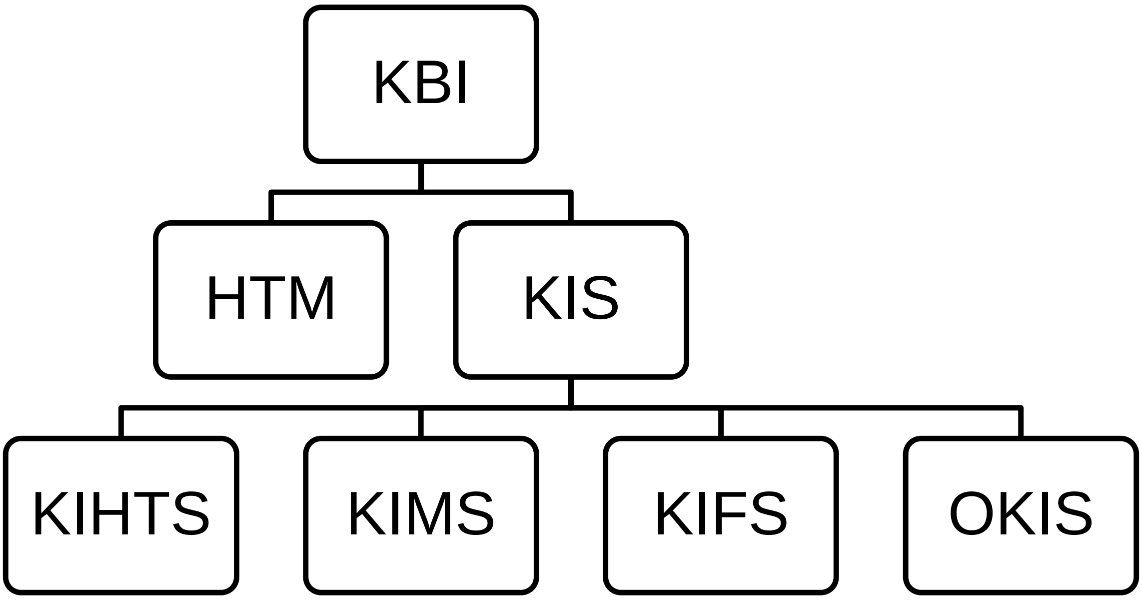
7.3.2 – Knowledge Inputs

Perhaps the most common approach to measuring regional knowledge endowment is to approximate the extent to which regional employment is engaged as an input to the knowledge production process. This is usually through the use of the proportion of the regional labour force that are employed in the Research and Development (R&D) sector, under the premise that the greater extent to which people are employed in producing knowledge at a regional level, the greater endowment of knowledge 'capital' at that regional level (Audretsch, Dohse and Niebuhr, 2010; Audretsch and Keilbach, 2004a; 2004b; 2004c; 2007; 2008a). This approach has its theoretical foundations in the 'Knowledge Production Function' (KPF) approach of Griliches (1979) and Jaffe's (1989) approach concerning the localisation of knowledge spillovers from academic research.

Bishop (2012) takes a much broader approach through using regional employment in Knowledge Based Industries (KBI), which includes the R&D sector, as an explanatory variable. Furthermore, KBI employment can be decomposed into specific sectors, as demonstrated by Bishop (2012) who uses employment in High Technology Manufacturing (HTM) and Knowledge Intensive Services (KIS) as separate explanatory variables. There are several benefits from taking this approach. First, it incorporates the internal knowledge producing activities of 'knowledge intensive' firms in KBIs, which can undoubtedly be considered to contribute to the regional ‘knowledge capital’ stock. Second, the decomposition of these sectors acknowledges the different criteria by which HTM and KIS are classified as knowledge intensive sectors (Bishop, 2012). In particular, HTM sectors are “usually defined as sectors which have high levels of R&D spending as a proportion of output”, whereas the criteria through which KIS are defined is a little more ambiguous (Bishop, 2012:649). KIS are typically identified as sectors that “have high technology intensity, are heavy users of such technology, have a highly skilled labour force and… involve creative industries” (Bishop, 2012:649). Third, it can be argued that both HTM and KIS have different effects on growth and entrepreneurship. For example, Bishop (2012:650) argues that “it is increasingly recognised that KIS firms play a crucial role in generating new knowledge as they not only produce knowledge themselves but also provide knowledge services to other firms, combining their own internal knowledge with that of their clients and external sources.” Thus, the nature in which this knowledge ‘intra-temporally’ spills over in the form of a new firm could very feasibly differ across sectors. This is perhaps demonstrated by the differing estimated effects of HTM and KIS employment in Bishop’s (2012) empirical results. These issues are linked with the literature regarding sectoral relatedness and how the composition of the regional knowledge stock might be important in a KSTE context, as discussed in Chapter 4, Section 4.4 and built upon in Section 7.8.3.

With regards to the latter of these, it could be argued that Bishop (2012) could go further than this, as according to the Eurostat criteria that he uses (Appendix: A3), the KIS sector can be further decomposed into four more specified sectors: Knowledge Intensive High-Tech Services (KIHTS), Knowledge Intensive Market Services (KIMS), Knowledge Intensive Financial Services (KIFS), and Other Knowledge Intensive Services (OKIS) (Figure 7.1). Through utilising regional employment across each of these sectors as separate explanatory variables, it is hoped that sectoral specific effects can be estimated that perhaps show different impacts on regional entrepreneurship in a KSTE context. This may indicate how different ‘types’ of knowledge spill over in the form of a new firm, or at least show how the knowledge generating activities and the way this knowledge is utilised within these specific sectors may influence knowledge spillover entrepreneurship. Theoretically, as all of these sectors are deemed knowledge intensive, it might be plausible to suggest that greater employment across any of the sectors may be conducive to entrepreneurial activity in a KSTE context; however, the empirical results of Bishop (2012) suggest that these sector specific effects could differ.

Figure 7.1. Decomposition of KBI into HTM and KIS sectors



Source: Eurostat (2014)

Data on regional employment across these sectors were gathered from NOMIS. As Eurostat uses a different coding system to the ONS (NACE vs SIC), the sector codes specified as knowledge intensive by Eurostat do not correspond perfectly with the Standard Industrial Classification (SIC) (ONS, 2014) codes, however they do correspond to a very high degree[12] such that any discrepancy is kept to a minimum. Table 7.1 shows the SIC sectors that were included in the HTM and KIS variables.

In terms of the spatial distribution of employment across these sectors, the quartile maps of HTM and KIS employment, as a proportion of total regional employment, show two very different spatial patterns (Appendix: A4 and A5). Employment in HTM has a much more

[12] One of the purposes for the ONS updating the SIC codes in 2007 was to bring them more in line with their Eurostat NACE counterparts.

random distribution, with no uniform spatial pattern being evident. However, there does seem to be some evidence that HTM tends to be located around motorways, as there are several regions in the top quartile for HTM employment (Appendix: A4) that are located along the M4 between London and South Wales, the M5 between Bristol and Birmingham, the M6 between Birmingham and Manchester, and the M11 between London and Cambridge. This is in comparison with the spatial distribution of KIS employment (Appendix: A5), which appears to be centred in the south, particularly surrounding London, but also generally in urban areas. Bishop (2008) also finds a similar spatial pattern in the form of 'rapid' growth in KIS employment "in a central cluster and major urban areas" occurring across GB between 1991 and 2002. Furthermore, his empirical model provides evidence that economic diversity in regional employment across two-digit industries appears to be the driver of this spatial variation in KIS employment. The reasons behind these spatial patterns in HTM and KIS employment are beyond the scope of this thesis, but this might tentatively suggest that the location decisions of new firm start-ups in HTM sectors are based more on distribution costs rather than other considerations, due to the fact that HTM produces goods that are not weightless. This is in contrast to the location decisions of start-ups in KIS, which are arguably based more on the availability of skilled labour, costs of relocation, and the advantages associated with local networks, factors that are more relevant to the KSTE process (Audretsch and Lehmann, 2005). These insights might also explain the differences in the effects of HTM and KIS employment on entrepreneurship observed in Bishop (2012). That employment in KIS shows this spatial pattern is perhaps to be expected, as it is well documented that the south of England is, and has been historically, more oriented towards service sector employment (Massey, 1984). The influence of London is again evident, showing a clear higher rate of KIS sector employment.

Table 7.1. SIC sectors included in HTM, KIHTS, KIMS, KIFS, and OKIS employment

KBI	*Sector Codes and Titles*
HTM	**21**: Manufacture of Pharmaceuticals **26**: Manufacture of computer, electronic and optical components **30.30**:Manufacture of air and spacecraft and related machinery
KIHTS	**53**: Postal and courier activities **58.2**: Software publishing **59**: Motion picture, video and television programme production, sound recording and music publishing activities **60**: Programming and broadcasting activities **61**: Telecommunications **62**: Computer programming, consultancy and related activities **63**: Information service activities **72**: Scientific research and development **95.1**: Repair of computers and communication equipment
KIMS	**50**: Water transport **51**: Air transport **68**: Real estate activities **69**: Legal and accounting activities **70**: Activities of head offices; management consultancy activities **71**: Architectural and engineering activities; technical testing and analysis **73**: Advertising and market research **77**: Rental and leasing activities **78**: Employment activities
KIFS	**64**: Financial service activities, except insurance and pension funding **65**: Insurance, reinsurance and pension funding, except compulsory social security **66**: Activities auxiliary to financial services and insurance activities
OKIS	**18.20**: Reproduction of recorded media **75**: Veterinary activities **85**: Education **86**: Human health activities **90**: Creative, arts and entertainment activities **91**: Libraries, archives, museums and other cultural activities

As the employment in KBIs and regional patent intensity variables are attempting to measure similar regional characteristics, namely regional knowledge endowment. All of these variables are expected to have a positive effect on regional entrepreneurship within the context of KSTE. The patent variable, in particular, is expected to have the most significant effect on regional entrepreneurship, as it is arguably the most complete measure of economically valuable regional knowledge.

It is perhaps prudent at this stage to briefly discuss descriptive statistics and correlations between these variables separately from the control variables that will also be used in the regression modelling. Table 7.2 shows the descriptive statistics for AVPAT and LNAVPAT, as well as HTM, KIHTS, KIMS, KIFS, and OKIS employment as a proportion of total regional employment, averaged over 2008 to 2010. Table 7.3 shows the correlation matrix for these variables.

Table 7.2. Global descriptive statistics of regional patent intensity (AVPAT and LNAVPAT) employment in HTM, KIHTS, KIMS, KIFS, and OKIS sectors as a proportion of total regional employment. The mean (μ) and standard deviations (σ) are weighted by regional population.

	μ	σ	CV	Min	Max
AVPAT	0.134	0.179	1.334	0.000	2.474
LNAVPAT	-2.010	0.671	-0.334	0.000	0.910
HTM	0.009	0.019	2.051	0.000	0.203
KIHTS	0.048	0.030	0.628	0.009	0.200
KIMS	0.117	0.044	0.376	0.042	0.376
KIFS	0.039	0.034	0.880	0.003	0.419
OKIS	0.172	0.044	0.258	0.021	0.416
KIS	0.376	0.084	0.223	0.175	0.815

Table 7.3. Correlation matrix of AVPAT, LNAVPAT, HTM, KIHTS, KIMS, KIFS, and OKIS variables. Correlation coefficients are calculated using Pearson product-moment correlation method (*r*).

	AVPAT	LNAVPAT	HTM	KIHTS	KIMS	KIFS	OKIS	KIS
AVPAT	X	X						
LNAVPAT	X	X						
HTM	0.080	0.138	X					
KIHTS	0.316	0.381	0.035	X				
KIMS	0.378	0.409	-0.081	0.449	X			
KIFS	0.421	0.207	-0.053	0.141	0.361	X		
OKIS	-0.199	-0.211	-0.152	-0.249	-0.305	-0.139	X	
KIS	0.390	0.335	-0.142	0.553	0.691	0.590	0.268	X

The descriptive statistics of Table 7.2 show that there is significant variation across the proxy variables for regional knowledge endowment. The AVPAT variable shows that there were, on average, 0.134 patents filed per 1000 people of working age across GB from 2009-2010. Moreover, the CV for this variable (1.334) suggests that regional patent intensity shows a greater amount of spatial variation than many of the other knowledge based variables; only the HTM variable shows a greater degree of spatial variation. The KBI employment variables show that, despite attempting to measure similar aspects of regional knowledge endowment, there are significant structural differences between them. The μ of the HTM variable shows that between 2008 and 2010, on average, 0.9% of employment throughout GB was involved in HTM; this compares with rates of 3.9% in KIFS, 4.8% in KIHTS, 11.7% in KIMS, 17.2% in OKIS, and 39% in KIS as a whole. HTM also shows a much greater spatial variation in comparison with the other knowledge based variables, exhibiting the highest CV and the largest range; where some regions did not have any employment in HTM over the time period analysed, some regions had as high as 20.3% employment in HTM. These descriptive statistics show that the knowledge sectors show significant difference in their spatial distributions, strengthening the case for the decomposition of KIS. This is further illustrated by the correlation matrix of Table 7.3. Whilst there is some moderate correlation between some of the knowledge based variables, none of them are particularly high given that they are attempting to quantify similar regional characteristics. In fact, the greater correlation coefficients are generally seen between the KIS variables and it components, which is to be. Overall, these statistics, as well as their respective quartile maps (Appendix: A4 and A5), show interesting patterns in the spatial distribution of knowledge across GB from 2008-2010; it remains to be seen whether this spatially dispersed knowledge significantly effects the generation of entrepreneurial opportunities at a regional level within the framework posited by the KSTE.

7.3.3 – Diversity

A recurring theme in the entrepreneurship literature, as well as the literature concerning the nature of knowledge spillovers and economic growth, is the role of diversity as a positive influence on these processes. Bae and Koo (2008) make the argument that local knowledge is open to both nascent entrepreneurs and incumbents and that “under technological regimes, incumbents will benefit more from local knowledge”. As a result, a large stock of regional knowledge “may or may not increase the stock of knowledge spilled over to nascent entrepreneurs” and accordingly, it is the nature and not the size of the knowledge stock that is important in a KSTE context (Bae and Koo, 2008:473); specifically it is argued that the diversity of knowledge is particularly stimulating to entrepreneurship.

Defining diversity as an economic concept is not necessarily straightforward in itself, but in this context it generally takes the form of either (1) a measurement of the relatedness of particular personal characteristics, such as ethnicity (Bishop, 2012) or political persuasion (Audretsch and Keilbach, 2007), across the regional population, or (2) a measurement of the diversity, variety, or relatedness across the sectoral activity of firms that operate within a region (Bishop, 2008; Bishop and Gripaios, 2009; Frenken, Van Oort and Verburg, 2007). As the first pertains to idiosyncratic differences amongst people, empirically assessing its impact on entrepreneurship will be an aspect of the next chapter, and instead the focus here will be on the diversity of firms' activity across industrial sectors within a region.

The impact of industrial diversity, as well as the associated concepts of related and unrelated variety, forms a part of the wider literature on endogenous growth and 'new economic geography', whereby realisable externalities, in the form knowledge spillovers, act as source of increasing returns on a regional level (Krugman, 1991; Romer, 1986; 1990). More specifically, much discussion centres on whether these spillovers occur as Marshall-Arrow-Romer (MAR) externalities (also referred to localisation economies) or Jacobian externalities (urbanisation economies), and which is the source of increasing returns (Döring and Schnellenbach, 2006; Feldman and Audretsch, 1999; Glaeser*, et al.*, 1992). MAR spillovers occur between researchers, entrepreneurs and firms within an industry, creating learning processes whereby "knowledge spills over between individuals working to solve similar or at least related problems… [as] intra-industrial phenomena that allow the exploitation of regional economies of scale" (Döring and Schnellenbach, 2006:382). Thus, localisation economies are "external to the firm but internal to an industry within a geographical region" (Feldman, 1999:14). The realisation of these 'localisation' economies in regions characterised by a "higher concentration of firms employing similar production technologies" should lead to these regions exhibiting "higher income growth rates than regions with a lower concentration of similar firms" (Döring and Schnellenbach, 2006:382). These insights imply that knowledge externalities only exist to a significant degree between firms of the same industry, such that intra-industry spillovers either do not exist or are 'trivial' (Feldman and Audretsch, 1999).

In contrast, Jacobian externalities (Jacobs, 1969) occur between industries and result in the exploitation of "regional economies of scope... widening the scope of research of individual industries through the interaction with other industries" (Döring and Schnellenbach, 2006:382). Furthermore, there is also an emphasis on collaboration between firms across industries, due to the fact that they are not in competition with one another. According to Feldman and Audretsch (1999), Jacobs (1969) argues that "the most important source of knowledge spillovers are external to the industry in which the firm operates". These 'urbanisation' economies are "noted to be the scale effects associated with city size or density" as "the diversity of these knowledge sources is greatest in cities" and the agglomeration of people facilitates the flow of ideas (Feldman, 1999:14). Thus, Jacobs (1969) suggests that it is diversity, and not specialisation, that is the 'operative mechanism of economic growth' (Feldman and Audretsch, 1999).

These arguments mainly relate to which form of knowledge spillover, MAR spillovers from regional specialisation or Jacobian spillovers from regional diversity, is the most conducive to economic growth. This is empirically testable and an abundance of empirical research has been conducted to quantify the effects of these spillovers on economic indicators, such as employment growth, at different geographical levels, such as across cities (Glaeser*, et al.*, 1992) or across regions (Bishop, 2008; 2009; Bishop and Gripaios, 2009). However, conclusive results are somewhat elusive. Döring and Schnellenbach's (2006) review of the topic highlights that empirical studies support both the MAR and Jacobian hypotheses, such that "the statement that both types of knowledge spillovers are empirically relevant is a rather safe claim" (Döring and Schnellenbach 2006:385). As a consequence of the ambiguous findings, there are "difficulties in generalising the results about the relative importance of both types of knowledge spillovers; which kind of knowledge spillover is dominant depends eventually on micro-level, i.e. sectoral and firm-level, conditions" (Döring and Schnellenbach 2006:385).

Despite this lack of consensus on the relevance of either type of spillover to economic growth, there are several persuasive arguments suggesting that industrial diversity is conducive to KSTE related entrepreneurial activity. For example, Andersson, Quigley and Wilhelmsson (2005) suggest that urbanisation economies are conducive to regional creativity and "*matter* to the creation of new knowledge". The Jacobian idea that "the most important source of knowledge spillovers are external to the industry in which the firm operates "(Feldman and Audretsch, 1999) is compelling as regards entrepreneurship as a conduit for knowledge spillovers in the KSTE context. Firms that produce innovative, knowledge based opportunities are likely to be less uncertain as to its potential value if such innovations are relevant to the industry in which they operate. It might follow that incumbents are more likely to exploit this knowledge, reducing the size of the knowledge filter and thus leaving fewer opportunities for nascent entrepreneurs to exploit should the regional knowledge stock be 'specialised'. Put succinctly, firms are likely to be more uncertain about the applicability of knowledge to sectors that they do not operate in, leaving potential opportunities for nascent entrepreneurs to exploit. From another perspective, a diverse industrial base is likely to lead to a diverse regional knowledge stock through the combination of knowledge from disparate economic activity. This is likely to create more knowledge based, innovative opportunities for nascent entrepreneurs to exploit as the combination of knowledge across diverse sectors is likely to result in a diverse stock of knowledge that incumbents find particularly uncertain. Diverse regional knowledge stocks are likely to exhibit a larger knowledge filter and create a greater amount of knowledge based entrepreneurial opportunities. Thus, the combination of knowledge from across diverse sectors creates innovative opportunities that are particularly uncertain to incumbents and are therefore exploited entrepreneurially.

As a result of its theoretical appeal, KSTE research has often included some measure of industrial diversity as an explanatory variable (Audretsch, Dohse and Niebuhr, 2010; Audretsch and Keilbach, 2008a; Bae and Koo, 2008; Bishop, 2012). The results of these studies illustrate the ambiguity regarding the relative relevance of MAR and Jacobian spillovers. Both Audretsch and Keilbach (2008a) and Audretsch, Dohse and Niebuhr

(2010), using German data, find that sectoral diversity has a negative impact on regional firm formation rates. Moreover, the results of Audretsch, Dohse and Niebuhr (2010) are shown to be quite robust, with results being invariant to the method in which diversity is measured and with the inclusion of spatial components in the models and different spatial weights. However, Bae and Koo (2008) and Bishop (2012), using US and UK data respectively, find that sectoral diversity has a positive effect on regional entrepreneurial activity.

Bae and Koo (2008) and Bishop (2012) introduce the concept of unrelated and related knowledge. Unrelatedness refers to a diverse stock of knowledge that is produced by firms operating in completely disparate sectors where there is a minimum possible overlap in activity. Relatedness refers to a less diverse stock of knowledge, comprising knowledge that has a degree of complementarity with other knowledge, such as that produced by firms operating in different but related sectors. To some extent, related diversity could be considered a compromise between the extremes of specialisation and unrelated diversity. Bae and Koo (2008) argue that both unrelated and related regional knowledge should positively influence entrepreneurship, but for different reasons. Unrelated diversity is said to affect entrepreneurship in the manner posited before, in that it creates a regional knowledge stock that is characterised by a greater degree of uncertainty, creating a greater number of opportunities for nascent entrepreneurs to exploit. Related knowledge could arguably create a greater number of opportunities, as “commercial opportunities are easier to identify and proliferate when there are related inventions and knowledge” (Bishop, 2012:645). Bae and Koo (2008) provide smartphones as an example of related knowledge creating an opportunity for innovation; providers of smartphones exploited the opportunity for digital convergence by combining knowledge from different electronics industries, through integrating mobile devices, internet content, digital cameras, and music devices. Whilst Bae and Koo (2008) argue that unrelated and related diversity should stimulate entrepreneurship, Bishop (2012) argues that the relationship is more ambiguous, particularly regarding related knowledge. Bishop (2012) makes the valid point that if commercial opportunities are easier to identify with related knowledge, it is not intuitively clear why these opportunities are not then appropriated by incumbents pre-empting nascent entrepreneurs. Nonetheless, the empirical results of both Bae and Koo (2008) and Bishop (2012) suggest that both unrelated and related regional sectoral diversity have a significantly positive effect on regional entrepreneurial activity. Moreover, Bishop's (2012) results are robust across a number of spatial models with different spatial weights.

Thus, a compelling theoretical and empirical case has been made that the impact of sectoral diversity, in the form of both unrelated and related diversity, on regional entrepreneurial activity is significant; however, the nature of this effect is somewhat ambiguous. Two approaches to diversity will be taken in the subsequent models; the first will consider both unrelated and related diversity specifically in terms of employment across the sectors of KBIs, as in Bishop (2012); the second will be a broader approach that is more common in the literature and will estimate the effect of regional diversity through considering the dispersion of regional employment across all 2-digit SIC sectors. The basic premise is that a region can be considered to be more diverse if employment is dispersed across industrial sectors, as opposed to being concentrated in merely a few; the former is more conducive to Jacobian externalities, whereas the latter is more conducive to the presence of MAR externalities.

Having specified the forms and nature of sectoral diversity, the problem then becomes how this diversity is to be quantified. Sectoral diversity can essentially be considered as a form of inequality in employment across industrial sectors within a region. Accordingly, many approaches to quantifying sectoral diversity utilise approaches that are common in the literature on income inequality (Cowell, 2011). These approaches involve the development of some form of inequality statistic that either increases or decreases according to whether employment is becoming less unequal (diverse) or more unequal (specialised).

Entropy measures of inequality will be utilised here to quantify knowledge diversity, as they have "the major advantage of being decomposable into related and unrelated components" (Bishop, 2012). Total knowledge entropy (TKE) is defined as:

$$TKE = \sum_{i=1}^{n} S_j ln\left(\frac{1}{s_j}\right)$$

Where s_j is the share of the *i*th 4-digit SIC category in a regions total KBI employment and n is the number of 4-digit category knowledge industries (Bishop, 2012). The value approaches $\ln(n)$ as employment becomes increasingly diversified, meaning that TKE increases as diversity increases. One issue with utilising this entropy measure is that the absence of employment in a particular sector within a region leaves the index undefined, as $s_j = 0$. To address this issue, the 0's were replaced with 0.001 for the calculation of the indices.

Similarly, unrelated entropy is defined at the SIC 2-digit level across the KBIs:

$$KUE = \sum_{j=1}^{m} S_j ln\left(\frac{1}{s_j}\right)$$

Where j refers to the number of 2-digit KBIs and s_j is the share of the *j*th knowledge sector.

Related knowledge entropy (KRE) is computed as the difference between TKE and KUE, such that:

$$KRE = TKE - KUE$$

Thus, the knowledge entropy figure decomposes into diversity across the 4-digit knowledge sectors within a particular 2-digit knowledge sector (KRE) and into diversity across all 2-digit knowledge sectors (KUE). This makes the assumption that 4-digit knowledge sectors within a 2-digit knowledge sector are more 'related' than 4-digit sectors between broader 2-digit sectors. Bishop (2012) argues that this assumption is perhaps dubious, as the SIC system is based on product similarities as opposed to technological similarities, such that this might be an imperfect measure of 'relatedness'; however the intuitive appeal of its decomposition, ease of calculation, and availability of relevant data at LAD level are several benefits of its use.

In terms of the broader measure of sectoral diversity, the Herfindahl-Hirschman Index (HHI) will be utilised; there is precedence for its use in the literature and it is a common and well accepted measure of inequality. Furthermore, the HHI is not affected by the lack of employment in any sector within a region.

The HHI is defined as:

$$HHI = \sum_{i=1}^{n} s_i^2$$

where s_j is the share of employment in the *i*th 2-digit sector, and n is the total number of 2-digit sectors (Lipczynski, Wilson and Goddard, 2005). The HHI exhibits an opposite trend to the entropy index, in that as sectoral diversity increases, the HHI decreases; accordingly, if diversity in employment across all sectors is conducive to regional entrepreneurship, then a negative estimated coefficient can be expected

As far as the spatial distribution of diverse regions across GB is concerned, quartile maps provide some evidence that regions clustered in central, southern, and south eastern GB tend to exhibit a greater degree of sectoral diversity across KBI employment, at least in terms of TKE (Appendix: A6) and KUE (Appendix: A7). This suggests that not only do these regions exhibit greater rates of employment in KBIs, at least in KIS, but that employment is also more likely to be dispersed across the knowledge sectors. The spatial distribution of regions exhibiting a greater degree of related knowledge diversity appears much more random, with no clear spatial tendency being evident (Appendix: A8). The spatial distributions of regions that exhibit a greater degree of employment diversity across all 2-digit sectors, denoted by the HHI, also tend to be located in the central and southern parts of GB, indicated by the lighter regions of the quartile map (Appendix: A9), although this tendency isn't too robust.

7.3.4 – Control Variables

Agglomeration of People and Services

Related to the concepts of knowledge spillovers, MAR externalities, and Jacobian externalities is how these are influenced by proximity and the agglomeration of people and services in space. The rationale for the existence of cities has been of interest to economists since at least Thünen in 1826 (Fujita and Thisse, 2002). Lucas (1993) asserts that the "only compelling reason for the existence of cities would be the presence of increasing returns to agglomerations of resources which make these locations more productive" (Feldman, 1999:15). As Feldman (1999) also suggests, "the effect of cross product increasing returns, where one activity increases the marginal product of another, is greater with proximity" in the context of Jacob's (1969) agglomerations, as this is where the proximity of people, firms, and industries is greatest. Theoretically, proximity should facilitate the flow of and generation of innovative ideas through reducing the cost of their transmission and by increasing the opportunity of interactions between people. Thus, the existence of diverse agglomerations forms an integral part of urbanisation economies and how they facilitate knowledge spillovers. Furthermore, Bishop (2012) argues that urban agglomerations may benefit from the presence of a range of institutions, such as regional development bodies and business support networks, which typically locate there.

Empirical studies of the KSTE often include some measure of agglomeration as a control variable to approximate the effects of urban agglomerations. Acs*, et al.* (2009) utilise the proportion of people who are living in urban areas to approximate the presence of urbanisation economies in their cross-country analysis. They find that countries with a higher proportion of people living in urban areas exhibit significantly higher entrepreneurial activity. Similarly, population density is another common way to measure urbanisation economies (Feldman, 1999). Both Audretsch and Keilbach (2008a) and (Bishop, 2012) use population density as explanatory variables, again showing that a greater agglomeration of individuals is conducive to entrepreneurship; however, Bishop's (2012) results show that the estimated effect is sensitive to spatial specification, as its significance disappears in the spatial models.

This study will utilise a measure of agglomeration in the form of employment density (EMPDENS). The reason for this is that the spillover of knowledge occurring through the interaction between people is more likely to occur when people are at their place of employment. Furthermore, networks that facilitate the spillover of knowledge are more likely to be professional rather than social in nature, and may be 'located' in areas of work and employment rather than in areas of residence. The City of London is perhaps an example of this. It has a rather average residential population density due to its unusually small residential population; however there are many interactions between people sharing knowledge that could possibly create agglomeration externalities, as nearly half a million people commute to work there on a daily basis. Data on employment was collated using the Business Register and Employment Survey (BRES) conducted by the ONS and available through NOMIS. It is expected that there exists a positive relationship between employment density and firm births.

<u>Barriers to Entrepreneurship</u>

Acs*, et al.* (2009) suggest that entrepreneurship may decrease under a higher administrative, regulatory, and governmental burden. Whilst this relationship is theoretically straight forward, the empirical validation is less so, as there are few potential proxy variables of these factors available at a local level that have sufficient spatial variation for use in a spatial econometric model. The proxy variables used by Acs*, et al.* (2009) relate to government expenditure as a proportion of GDP and taxation rates as rough approximations of government intervention in the market. The main premise is that a greater degree of government intervention in the market increases the cost, or decreases the return, of entrepreneurship. Occupational choice models of entrepreneurship (Evans and Jovanovic, 1989; Kihlstrom and Laffont, 1979) suggest that the potential returns to entrepreneurship are a determining factor in peoples' proclivity towards entrepreneurship.

If these potential returns minus some risk premium exceed what can be earned in guaranteed wages, people will decide to become entrepreneurs. Whilst this makes many assumptions about the nature of entrepreneurship, it can still be argued that if taxes on those entrepreneurial returns are increased, some will choose to stay as wage workers instead of becoming entrepreneurs. Of course, an increase in income tax rates whilst maintaining other taxes may have the opposite effect and encourage entrepreneurial activity. This is demonstrative of the ambiguity that accompanies proxy variables of 'barriers to entrepreneurship' that are of this nature.

Furthermore, there are wider institutional constraints that might as a 'barrier to entrepreneurship' that can be linked with the social capital literature. Specifically, it can be argued that the absence of social capital, or the effects of certain forms of social capital (Bowles and Gintis, 2002; Casson and Giusta, 2007), that is 'spatially bounded' (Westlund and Bolton, 2003) can reduce the resources available to the entrepreneur and the utility derived from entrepreneurship, as discussed at greater length in Chapter 4, Section 4.4. However, these considerations do not lend themselves particularly well to the spatial econometric analysis being utilised in this thesis, as spatially varied local social capital is largely an unobservable phenomenon defying quantification. Thus, these unobservable phenomena will be embodied in the error term and this may have consequences for the reliability of the OLS estimates. However, the use of spatial econometric methods, and in particular the use of spatial error models utilising a spatially autoregressive error component that allows for a variation in these unobservable characteristics over space, will alleviate this issue. Alternatively, a different methodological approach that involved qualitative research methods might provide greater insight into the nature of barriers to entrepreneurship, as barriers could arguably be quite personal and unique to the individual entrepreneur and these aspects are typically lost in aggregated approaches necessary for econometric investigation.

In light of these issues, the measurement of local 'barriers to entrepreneurship' in this thesis will be similar to the methods used in previous KSTE literature (e.g. Acs, *et al.*, 2009), as regional employment in public administration, as a proportion of total regional employment, will be utilised as a suitable proxy variable (PSEMP). The data encompassed those employed in the sector '84: Public administration and defence; and compulsory social security', using the 2007 SIC codes; it is hoped that this will approximate some aspect of government intervention in the local economy. Of course, there are aspects of other sectors, such as 85: Education and 86: Health, which are considered as part of the 'public' sector, but these two sectors are also considered to be knowledge intensive and are hypothesised to positively influence entrepreneurial activity. Furthermore, the emphasis on administration and regulation in the '84: Public administration and defence; and compulsory social security' sector is particularly relevant to investigating the bureaucratic and administrative costs of entrepreneurship.

Unemployment

Empirical investigations of the relationship between unemployment and entrepreneurship have yielded ambiguous results. Whilst Schuetze (2000) finds a significantly positive relationship between unemployment and self-employment, Blanchflower (2000) and Bishop (2012) find that similar relationships are significantly negative; others, such as Moore and Mueller (2002), do not find a relationship of any significance. Admittedly, the ambiguity of the results could be attributed to methodological differences. For instance, Blanchflower (2000) conducts an analysis using 23 OECD countries in order to quantify the relationship, whereas Schuetze (2000) conducts a regional comparison of the US and Canada; both of these studies derive completely opposite results. It is reasonable to suggest that the contradictions in their findings might, to some extent, be attributed to their different geographical units of observation and that studies using different geographical units are not directly comparable.

The effect of unemployment on entrepreneurial activity could theoretically be either positive or negative. The positive impact of unemployment on entrepreneurship comes from the concept of 'push factors' (Moore and Mueller, 2002) and the notion that wages are an opportunity cost of entrepreneurship in occupational choice models (Evans and Jovanovic, 1989; Kihlstrom and Laffont, 1979). In these approaches, a rise in unemployment should generate a rise in entrepreneurship, due to the fact that: (1) high unemployment represents poor employment opportunities and ‘pushes’ people into entrepreneurship and (2) if the opportunity cost of entrepreneurship is the forgoing of a certain wage for a risky profit, a person that is unemployed effectively has a low opportunity cost , making entrepreneurship a more attractive proposition (Noorderhaven*, et al.*, 2004). Both of these factors suggest a positive relationship between unemployment and entrepreneurship. Conversely, a high local unemployment rate may act as a signal of poor local demand and discourage entrepreneurs from starting a new firm locally as the prospect of satisfactory profits might be low. These two contrary effects are highlighted by Noorderhaven*, et al.* (2004). It is possible that the potentially positive and negative effects of unemployment on entrepreneurship could occur at the same time and that either one may be dominant.

In order to effectively measure regional unemployment, the study uses claimant count data that measures the proportion of the population aged 18-64 claiming Jobseeker’s Allowance (JSA) (CLAIMRATE). Whilst this is not an official measure of unemployment, data collected at LAD level regarding the claimant rate is consistent across all regions and years whereas other measures of unemployment are typically estimated. Additionally, the claimant count has the added benefit of accounting for the unemployed who are *actively* seeking employment, as this has to be proven in order to claim for JSA, and it is these individuals who are perhaps the most relevant to the current analysis. The quartile map showing how claimant rates differ across regions of GB (Appendix: A10) suggests that many urban agglomerations, such as East London, Birmingham and Wolverhampton, Liverpool, Greater Manchester, Cardiff, and Glasgow, rank in the highest quartile of regions. There is also some evidence that unemployment in the OIRs of south Wales, the north and north east of England, and southern Scotland is indeed higher than in other parts of GB, substantiating the claims of Beatty, Fothergill and Powell (2005) and Birch, MacKinnon and Cumbers (2010).

Regional incomes and the Availability of Finance

The effect of incomes on entrepreneurial activity can also theoretically be both negative and positive. Occupational choice models (Kihlstrom and Laffont, 1979; Evans and Leighton 1989) envisage income as an opportunity cost to entrepreneurship, such that a negative relationship should be expected. Conversely, higher regional wage levels may represent additional resources for nascent entrepreneurs looking to finance their new firm (Bishop, 2012). In particular, regions with higher incomes may have a local population with greater access to personal capital in the form of savings, as well as a higher potential to be granted a greater amount of secured, borrowed finance from financial institutions. For example, Black, Meza and Jeffreys (1996) investigate "the extent to which the supply of collateral affects business formation" using UK data, based on the premise that bank loans are typically secured on the entrepreneur's house. Their results suggest that a 10% rise in 'net housing equity' increases the number of VAT registrations by 5%, providing "evidence that collateral availability is a major influence on aggregate rates of firm formation" (Black, Meza and Jeffreys, 1996). More recently, Fairlie and Krashinsky (2012) show that both wealth and housing appreciation is a significantly positive determinant of entry into self-employment, finding that "entry rates generally increase as wealth rises". Bishop's (2012) study using UK data on regional incomes and VAT registrations finds similar evidence that higher regional incomes positively affects regional entrepreneurship through reducing resource constraints. Thus, there seems to be compelling evidence of the positive causal relationship between incomes and entrepreneurship in this regard. Furthermore, this positive relationship might also work on the demand side. Firms may wish to locate in areas that have higher incomes in order to capitalise on potentially higher local demand, particularly in the service sectors where services are often consumed on a local level due to the impossibility of transporting some services. Both of these points theoretically suggest that regional incomes should be positively related to firm birth rates.

This study will follow Bishop's (2012) example through using regional incomes as a measure of the resource constraints faced by nascent entrepreneurs, under the premise that higher incomes result in fewer resource constraints and greater entrepreneurial activity. Whereas Bishop (2012) uses mean gross weekly pay as an explanatory variable, this study will utilise the median gross weekly pay of the regional resident population (INCOME). This is due to the fact that income distributions tend to exhibit a significant positive skew, and as such the median is perhaps a more reliable measure of central tendency in income distributions across a regional population. The quartile map showing regional median incomes (Appendix: A11) shows a very clear North/South divide; the darker regions signifying higher median incomes are almost all concentrated around London. This significant clustering of regions with higher incomes is likely to have a significant influence on explaining spatial variations in firm births. However, a word of caution might be needed in the interpretation of the significance of the estimated coefficient on the median income variable, as it may suffer from bias. Higher incomes tend to be associated with people endowed with a greater human capital, typically accrued through education, such that the positive effect of income on firm births could partly be attributed to the effect of human capital and entrepreneurial ability acting through the income variable. This will, however, be controlled for in the following chapter to examine whether this is a major issue.

<u>OIRs and Local Entrepreneurial Culture</u>

As was observed in the previous chapter, there were several significant clusters of regions that exhibited low firm birth rates, and these regions were associated with OIRs (Birch, MacKinnon and Cumbers, 2010). Accordingly, it was hypothesised that these regions might exhibit poor entrepreneurial activity due to the absence of an adequate local entrepreneurial culture, resulting from their heavily industrialised past. Entrepreneurial culture is said to be time persistent due to path dependent forces associated with positive feedback mechanisms and institutional hysteresis (Fritsch and Wyrwich, 2012; Martin and Sunley, 2006). This study will attempt to estimate the possible effect of entrepreneurial culture in this context, whilst controlling for other relevant structural effects through the other explanatory variable in the models. A dummy variable will be assigned to LADs that correspond to the NUTS 2 regions used by Birch, MacKinnon and Cumbers (2010) designated as OIRs (OIR). If the lack of entrepreneurial culture is significantly hindering entrepreneurial activity in these regions, then the estimated coefficient on the OIR dummy will be negative and significant.

7.4 – Descriptive Statistics

Table 7.4. Descriptive statistics of diversity indices and control variables

	μ	σ	CV	Min	Max
KRE	0.913	0.107	0.117	0.447	1.187
KUE	2.316	0.210	0.091	1.605	2.792
HHI	0.052	0.011	0.221	0.032	0.127
EMPDENS	1024.580	6212.610	6.064	3.652	119622.404
PSEMP	0.053	0.029	0.546	0.011	0.311
CLAIMRATE	2.686	1.101	0.410	0.398	6.195
INCOME	490.535	75.140	0.153	254.000	904.967

Table 7.5. Correlation matrix of diversity indices and control variables. Correlation coefficients are calculated using Pearson's product-moment correlation method (*r*).

	KRE	KUE	HHI	EMPDENS	PSEMP	CLAIMRATE	INCOME
KRE	X						
KUE	-0.109	X					
HHI	-0.030	-0.609	X				
EMPDENS	0.000	0.023	0.267	X			
PSEMP	-0.053	-0.296	0.344	-0.045	X		
CLAIMRATE	0.049	-0.275	0.049	-0.001	0.202	X	
INCOME	-0.034	0.470	-0.037	0.288	-0.204	-0.362	X

In addition to the knowledge based variables discussed previously, the descriptive statistics of the other explanatory variables used in the following models are summarised in Table 7.4. The public sector descriptive statistics indicate the vastly different tendency for regional employment to be geared towards the public sector, with almost a third of employment in one LAD (Castle Morpeth) being employed in public administration, six times the national average. The employment density variable shows how the regions of GB are vastly different in terms of their urbanisation. The CV of the employment density variable is very large, and the LAD with the greatest density of employment (City of London) in GB exhibits a density over one hundred times greater than the national average. These descriptive statistics hint at the spatial variation of many structural factors across regions of GB. The correlation matrix of these diversity indices and control variables is shown in Table 7.5. The only real concern with the cross correlates of the explanatory variables is the fairly strong negative correlation coefficient, -0.609, between KUE and HHI. As a precautionary measure, some of the regression models will be computed with the HHI variable excluded, in order to test the sensitivity and tolerance of the estimated coefficient on the KUE variable to the HHI variable. The data sources of all of the explanatory variables can be found in the Appendix (A12).

7.5 – OLS Linear Regression Results

Table 7.6. OLS linear regression results. Dependent variable: LNFB1000. No. of observations = 408

	M1	M2	M3	M4	M5
Constant	0.246 (0.371)	0.445 (0.104)	0.415 (0.101)	0.575 (0.012)**	0.542 (0.007)***
Regional Patent Intensity (AVPAT)	0.085 (0.318)				
Ln (Regional Patent Intensity) (LNAVPAT)		0.044 (0.004)***	0.046 (0.007)***	0.044 (0.005)***	0.046 (0.008)***
University Dummy (UNIDUM)	-0.101 (0.00)***	-0.097 (0.00)***	-0.090 (0.00)***	-0.096 (0.00)***	-0.089 (0.00)***
High Technology Manufacturing (HTM)	0.773 (0.249)	0.589 (0.371)	0.173 (0.800)	0.626 (0.356)	0.212 (0.763)
Knowledge Intensive Financial Services (KIFS)	0.172 (0.645)	0.158 (0.633)		0.183 (0.619)	
Knowledge Intensive High-tech Services (KIHTS)	0.024 (0.960)	-0.015 (0.975)		-0.003 (0.995)	
Knowledge Intensive Market Services (KIMS)	1.650 (0.00)***	1.516 (0.00)***		1.543 (0.00)***	
Other Knowledge Intensive Services (OKIS)	0.047 (0.876)	-0.047 (0.880)		-0.001 (0.997)	
Knowledge Intensive Services (KIS)			0.291 (0.170)		0.321 (0.122)
Related Knowledge Entropy (KRE)	0.325 (0.001)***	0.303 (0.002)***	0.164 (0.062)*	0.293 (0.003)***	0.158 (0.082)*
Unrelated Knowledge Entropy (KUE)	0.220 (0.015)**	0.192 (0.029)**	0.266 (0.00)***	0.153 (0.038)**	0.226 (0.00)***
Broad Industrial Diversity Index (HHI)	0.999 (0.514)	1.092 (0.469)	1.015 (0.533)		
Employment Density (EMPDENS)	0.00004 (0.00)***	0.00004 (0.00)***	0.00004 (0.00)***	0.00004 (0.00)***	0.00004 (0.032)**
Public Sector Employment (PSEMP)	-0.694 (0.051)*	-0.598 (0.079)*	-0.808 (0.021)**	-0.506 (0.122)	-0.720 (0.00)***
Claimant Rate (CLAIMRATE)	-0.061 (0.00)***	-0.056 (0.00)***	-0.058 (0.00)***	-0.058 (0.00)***	-0.059 (0.00)**
Median Incomes (INCOME)	0.0014 (0.00)***	0.0014 (0.00)***	0.0015 (0.00)***	0.0014 (0.00)***	0.0015 (0.00)***
Old Industrial Region Dummy (OIR)	-0.089 (0.002)***	-0.090 (0.002)***	-0.098 (0.00)***	-0.092 (0.001)***	-0.101 (0.00)***
City of London Dummy (LONDUM)	-1.853 (0.00)***	-1.807 (0.00)***	-2.143 (0.00)***	-1.783 (0.00)***	-2.120 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using HAC standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
R^2	0.804	0.807	0.798	0.807	0.798
F Statistic	100.488 (0.00)***	102.643 (0.00)***	119.679 (0.00)***	109.398 (0.00)***	129.616 (0.00)***
Log likelihood	180.598	184.087	173.978	183.534	173.520
AIC	-327.197	-334.175	-319.956	-335.069	-321.041
Breusch Pagan Test	37.021 (0.002)***	40.961 (0.00)***	51.478 (0.00)***	24.389 (0.059)*	29.001 (0.003)***

Table 7.6 displays the linear regression results for models M1-M5 using an OLS estimation procedure, with each model using different combinations of the explanatory variables. M1 utilises the untransformed patent variable and the decomposed KIS sectors, KIFS, KIHTS, KIMS, and OKIS, treated separately. M2 uses the natural log transform of the patent variable (LNAVPAT) whilst otherwise being consistent with M1. M3 utilises the LNAVPAT variable and the aggregation of the KIFS, KIHTS, KIMS, and OKIS variables into a single KIS variable. M4 and M5 are reformulations of M2 and M3 with the HHI variable excluded as a precautionary measure due to its high correlation with the KUE variable.

In terms of the explanatory power of the models as a whole, it can be seen that the explanatory variables explain 79%-81% of the spatial variation in firm birth rates across the LADs of GB from 2008 to 2010. This explanatory power remains consistent across the models regardless of how the patent and KIS sector variable are treated, or whether the HHI variable is included or excluded. The AIC is 'minimised' to the greatest extent in the two models (M2 and M4) where the log transformed patent variable and, more importantly, the decomposed KIS sector variables were used. That the information content of the models increases with the decomposed KIS sectors suggests that the explanatory power of the models increases to a greater extent relative to the information lost as a result of the increase in model of parameters. This provides evidence that decomposing the KIS sectors into separate explanatory variables provides models with greater informational content relative to models that treat the KIS sectors as a single, aggregated variable. Unfortunately, the residuals of all of the models exhibited heteroskedasticity, as indicated with each of the models failing the Breusch Pagan test; accordingly, the standard errors used to compute the p-values of the coefficient estimates were adjusted using heteroskedasticity consistent HAC standard errors to ensure the robustness of the inference of the estimated coefficients.

Whilst a wider contextual analysis of the implications of the estimated coefficients will be conducted in Section 7.8, it will be prudent at this stage to undertake a brief interpretation of each of the estimated coefficients here. The regression estimates suggest mixed results concerning the effect of regional knowledge stocks on entrepreneurial activity using GB data from 2008-2010. First, the AVPAT variable appears to be insignificant in M1, however the log transform of this variable is positive and highly significant across models M2-M5. A literal interpretation of the LNPAT would suggest that a 1% increase in the number of patents filed per 1000 people in a region should correspond with a 0.04% increase in in firm births per 1000 people, *ceteris paribus*; whilst being a small marginal effect, it is considered to be significantly different from 0 at a 99% confidence level across models M2 to M5. A slightly counterintuitive result, as far as the KSTE is concerned, is observed in the UNIDUM variable; the negative estimated coefficients, significantly different from 0 across all of the models, suggest that LADs with a university exhibit approximately 8%- 10% lower firm birth rates. The nature of this negative and significant university effect is discussed in greater detail in Section 7.8.2.

As far as the effect of employment in KBIs on knowledge based entrepreneurship is concerned, the results are fairly weak. There was no evidence that employment in HTM, KIFS, KIHTS, or OKIS has any effect on entrepreneurial activity across any of the models presented here. However, the results do suggest that increased employment in KIMS has a positive impact on firm births, as its estimated coefficient is positive and significantly different from 0 at a 99% confidence level across all of the relevant models. When the KIS sectors are aggregated into a single KIS variable, the estimated coefficients suggest that there appears to be no evidence of any significant effect of general KIS employment on firm birth rates on a regional level; the positive effect of KIMS employment is cancelled out by the non-significant estimated coefficients of KIFS, KIHTS, and OKIS.

The effect of the knowledge entropy indices, indicating the diversity in employment across KBI sectors, shows something altogether different; the positive and significantly different from 0 estimated coefficients on both the KUE and KRE variables suggest that it is not the absolute employment in KBI sectors that influences entrepreneurship in a KSTE context, it is instead the diversity of employment across these KBI sectors that matters. The estimated effect of KUE is arguably more robust than the estimated effect of KRE, as the significance of KRE appears sensitive to the inclusion of the aggregated KIS variable; however this sensitivity is fairly minor, as the KRE is still estimated to be significant at a 90% level when the aggregated KIS variable is included. These results concur with the findings of Bishop (2012). As far as broad sectoral diversity is concerned, the estimated coefficient on the HHI variable is insignificant across all of the relevant models. Thus, diversity appears to matter across KBIs as opposed to all industries. This perhaps highlights that urbanisation economies and Jacobian externalities are most likely to occur as a result of spillovers of knowledge between KBIs. This should also be considered with the agglomerative effects approximated with the EMPDENS variable. The estimated coefficient on the EMPDENS variable is highly significant across all of the models. The positive coefficient seems to indicate the presence of significant agglomerative effects resulting from dense employment within a region; when considered in the context of the KSTE, it would seem to suggest that a closer proximity between people in their place of work facilitates the flow of knowledge between them, resulting in the combination of this knowledge into opportunities for nascent entrepreneurs to exploit. This is further evidence of the relevance of urbanisation economies and Jacobian externalities to the creation of entrepreneurial opportunities; diverse employment across knowledge sectors results in a greater amount of entrepreneurial opportunities, as the combination of knowledge across diverse KBI sectors creates a diverse knowledge stock that is particularly uncertain to incumbents.

There is also some support for the 'Barriers to Entrepreneurship' hypothesis proffered by Acs*, et al.* (2009). The estimated coefficient on PSEMP is negative and significantly different from 0 at a 90% confidence level in M1 and M2, and at a 95% confidence level in M3 and M5. However, no significance was found in M4. As for the effect of unemployment on entrepreneurship, the regression results provide evidence in support of unemployment being a signal for poor local demand that discourages entrepreneurship, as opposed 'pushing' people into entrepreneurship as a result of poor paid employment opportunities (Moore and Mueller, 2002). This is in line with the empirical results of Bishop (2012) using similar data. The estimates are also shown to be robust across all of the OLS models presented, with its estimate being insensitive to the other explanatory variables in the models. A literal interpretation of this variable throughout models M1-M5 and SM1-SM10 would suggest that a one point increase in the claimant rate tends to decrease firm births by between 5% and 7%, *ceteris paribus*.

A similar inference can be made regarding the INCOME variable. The positive and statistically significant estimated coefficient appears to contradict occupational choice theory that would suggest a negative relationship between wage levels and entrepreneurship. Instead, it provides support for the concept that higher regional incomes represent fewer resource constraints and greater access to capital (Bishop, 2012). This estimate is also fairly robust, being consistent across all of the models presented and estimated as significantly different from 0 at a 99% confidence level; taken literally, the estimated coefficients would suggest that a £100 increase in the regional weekly median wage would tend to cause a 14%-15% increase in the regional firm birth rate, *ceteris paribus*.

Perhaps one of the more interesting results concerns the estimated coefficient on the OIRDUM indicator variable, suggesting that, even when controlling for a number of other structural factors, OIRs tend to exhibit a significantly lower firm birth rate that other areas of GB. As the models control for many of the structural factors such as unemployment that characterise OIRs (Beatty, Fothergill and Powell, 2005), the results might be said to provide evidence that these regions lack that "aggregate psychological trait" that typifies a 'local entrepreneurial culture' (Fritsch and Wyrwich, 2012). Typically, an OIR could be expected to have a 9%-10% lower firm birth rate, *ceteris paribus*, and this result is estimated to be significantly different from 0 at a 99% confidence level across all of the OLS models here presented here. Finally, the estimated coefficient on the LONDUM is negative and significant across all of the models. Of course, this was only included as a control measure due to the City of London being an extreme outlier, and the result might seem a little counter intuitive; however, it is proffered that much of the variation in the City's firm birth rate is estimated with the EMPLOYDENS variable, perhaps explaining the negative coefficient and suggesting that the City of London effect is predominantly a density effect. Whilst it appears that the inclusion of the EMPDENS variable controls for the effect of the City of London, the LONDUM indicator variable will remain in the models for completeness.

Having estimated models M1-M5 using an OLS linear regression estimation procedure, the next stage is to estimate these models with an appropriate spatial specification, using two different forms of spatial weights matrix at two different orders. The first spatial weights matrix will be based on the Queens Contiguity criterion of orders 1 (QCO1) and 2 (QCO2), whereas the second set of spatial models will utilise spatial weights matrices based on the nearest neighbours principle, designating the 4 (4NN) and 8 (8NN) nearest regions as neighbours. Spatial weights based on the nearest neighbour's principle were used, as opposed to spatial weights based on threshold distance, due to their precedence in the literature (Bishop, 2012) and software limitations that precluded the use of non-symmetric spatial weights in spatial regressions. Generally, the spatial diagnostics of the OLS models M1-M5 (Appendix: A13) suggest that a spatial error model specification should be followed when using contiguous spatial weights and a spatial lag specification should be followed with nearest neighbour spatial weights. These two approaches differ in method and in their dependence structures, such that the estimated coefficients of explanatory variables in spatial lag models can no longer be interpreted as partial derivatives; however the statistical inference of the estimated coefficients is still comparable across spatial lag and error models. Sections 7.6 and 7.7 summarise the results from these models.

7.6 – ML Spatial Regression Models with Contiguous Spatial Weights

Table 7.7. Spatial error models of M1-M5 using QCO1 spatial weight matrix. Dependent variable: LNFB1000. No. of observations = 408.

	SM1	SM2	SM3	SM4	SM5
Constant	0.396 (0.003)***	0.636 (0.003)***	0.642 (0.002)***	0.761 (0.00)***	0.770 (0.00)***
Regional Patent Intensity (AVPAT)	0.223 (0.001)***				
Ln (Regional Patent Intensity) (LNAVPAT)		0.053 (0.00)***	0.055 (0.00)***	0.053 (0.00)***	0.055 (0.00)***
University Dummy (UNIDUM)	-0.064 (0.002)***	-0.065 (0.002)***	-0.058 (0.006)***	-0.063 (0.003)***	-0.056 (0.007)***
High Technology Manufacturing (HTM)	-0.0002 (0.999)	-0.043 (0.919)	-0.249 (0.556)	-0.015 (0.972)	-0.219 (0.605)
Knowledge Intensive Financial Services (KIFS)	0.219 (0.493)	0.157 (0.622)		0.191 (0.549)	
Knowledge Intensive High-tech Services (KIHTS)	-0.127 (0.723)	-0.047 (0.894)		-0.048 (0.892)	
Knowledge Intensive Market Services (KIMS)	1.218 (0.00)***	1.089 (0.00)***		1.111 (0.00)***	
Other Knowledge Intensive Services (OKIS)	0.045 (0.843)	-0.004 (0.987)		0.030 (0.895)	
Knowledge Intensive Services (KIS)			0.203 (0.192)		0.229 (0.136)
Related Knowledge Entropy (KRE)	0.156 (0.063)*	0.145 (0.085)*	0.065 (0.403)	0.135 (0.108)	0.056 (0.465)
Unrelated Knowledge Entropy (KUE)	0.242 (0.00)***	0.220 (0.002)***	0.262 (0.00)***	0.183 (0.003)***	0.223 (0.00)***
Broad Industrial Diversity Index (HHI)	1.054 (0.263)	1.026 (0.277)	1.020 (0.283)		
Employment Density (EMPDENS)	0.00002 (0.00)***	0.00002 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-0.330 (0.232)	-0.277 (0.319)	-0.368 (0.186)	-0.180 (0.495)	-0.270 (0.306)
Claimant Rate (CLAIMRATE)	-0.060 (0.00)***	-0.060 (0.00)***	-0.061 (0.00)***	-0.061 (0.00)***	-0.062 (0.00)***
Median Incomes (INCOME)	0.0013 (0.00)***	0.0012 (0.00)***	0.0013 (0.00)***	0.0013 (0.00)***	0.0013 (0.00)***
Old Industrial Region Dummy (OIR)	-0.080 (0.002)***	-0.083 (0.001)***	-0.090 (0.00)***	-0.084 (0.001)***	-0.091 (0.00)***
City of London Dummy (LONDUM)	-0.636 (0.248)	-0.686 (0.211)	-0.986 (0.069)*	-0.666 (0.224)	-0.961 (0.077)*
Lambda (λ)	0.550 (0.00)***	0.526 (0.00)***	0.545 (0.00)***	0.526 (0.00)***	0.544 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.842	0.842	0.838	0842	0.838
Log Likelihood	240.432	211.962	205.883	211.372	205.308
AIC	-386.865	-389.925	-383.766	-390.744	-384.616
Breusch Pagan Test	38.781 (0.001)***	37.084 (0.002)***	40.094 (0.00)***	27.296 (0.026)**	28.696 (0.004)***
Wald Test	106.905	92.16	103.449	92.083	102.982
Likelihood Ratio Test	59.668 (0.00)***	55.750 (0.00)***	63.810 (0.00)***	55.675 (0.00)***	63.575 (0.00)***
LM Test	25.208	26.037	32.968	25.696	32.504

Table 7.8. Spatial error models of M1-M5 using QCO2 spatial weights matrix. Dependent variable: LNFB1000. No. of observations = 408.

	SM6	SM7	SM8	SM9	SM10
Constant	0.543 (0.008)***	0.763 (0.00)***	0.748 (0.00)***	0.769 (0.00)***	0.747 (0.00)***
Regional Patent Intensity (AVPAT)	0.160 (0.013)**				
Ln (Regional Patent Intensity) (LNAVPAT)		0.049 (0.00)***	0.048 (0.00)***	0.049 (0.00)***	0.048 (0.00)***
University Dummy (UNIDUM)	-0.089 (0.00)***	-0.087 (0.00)***	-0.078 (0.00)***	-0.087 (0.00)***	-0.078 (0.00)***
High Technology Manufacturing (HTM)	0.327 (0.466)	0.198 (0.660)	-0.115 (0.800)	0.199 (0.658)	-0.115 (0.799)
Knowledge Intensive Financial Services (KIFS)	0.428 (0.190)	0.388 (0.232)		0.389 (0.229)	
Knowledge Intensive High-tech Services (KIHTS)	-0.420 (0.244)	-0.360 (0.309)		-0.360 (0.309)	
Knowledge Intensive Market Services (KIMS)	1.303 (0.00)***	1.179 (0.00)***		1.179 (0.00)***	
Other Knowledge Intensive Services (OKIS)	-0.0092 (0.970)	-0.061 (0.805)		-0.059 (0.809)	
Knowledge Intensive Services (KIS)			0.215 (0.184)		0.215 (0.180)
Related Knowledge Entropy (KRE)	0.275 (0.002)***	0.259 (0.003)***	0.162 (0.040)**	0.258 (0.003)***	0.162 (0.038)**
Unrelated Knowledge Entropy (KUE)	0.206 (0.003)***	0.187 (0.008)***	0.236 (0.00)***	0.185 (0.003)***	0.236 (0.00)***
Broad Industrial Diversity Index (HHI)	-0.056 (0.953)	0.048 (0.959)	-0.013 (0.989)		
Employment Density (EMPDENS)	0.00002 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.0003 (0.00)***	0.0003 (0.00)***
Public Sector Employment (PSEMP)	-0.442 (0.109)	-0.380 (0.168)	-0.516 (0.064)*	-0.375 (0.153)	-0.517 (0.050)*
Claimant Rate (CLAIMRATE)	-0.076 (0.00)***	-0.074 (0.00)***	-0.076 (0.00)***	-0.074 (0.00)***	-0.076 (0.00)***
Median Incomes (INCOME)	0.0011 (0.00)***	0.0011 (0.00)***	0.0011 (0.00)***	0.0011 (0.00)***	0.0011 (0.00)***
Old Industrial Region Dummy (OIR)	-0.050 (0.037)**	-0.054 (0.024)**	-0.056 (0.020)**	-0.054 (0.024)**	-0.056 (0.020)**
City of London Dummy (LONDUM)	-0.861 (0.134)	-0.849 (0.137)	-1.009 (0.078)*	-0.847 (0.137)	-1.009 (0.077)*
Lambda (λ)	0.726 (0.00)***	0.712 (0.00)***	0.707 (0.00)***	0.713 (0.00)***	0.707 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.835	0.837	0.830	0.837	0.830
Log Likelihood	203.371	206.165	197.353	206.164	197.353
AIC	-372.742	-378.33	-366.705	-380.328	-368.705
Breusch Pagan Test	30.315 (0.016)**	28.340 (0.029)**	37.828 (0.00)***	26.247 (0.036)**	32.441 (0.001)***
Wald Test	128.007	116.726	112.572	116.986	112.508
Likelihood Ratio Test	45.545 (0.00)***	44.155 (0.00)***	46.749 (0.00)***	45.259 (0.00)***	47.664 (0.00)***
LM Test	21.158	20.728	23.245	22.268	24.739

Table 7.7 and Table 7.8 display the appropriate spatial specification of models M1-M5 using a maximum likelihood estimation procedure and QCO1 and QCO2 spatial weights respectively. First, the spatial component, Lambda (λ), is highly significant across all of the models with both forms of spatial weight matrix, indicating the need for spatial econometric techniques to control for spatial autocorrelation. This is further affirmed by the Likelihood Ratio (LR) tests, which compares the 'fit' of the alternative models (the spatial models) against the null models (the non-spatial OLS counterparts) to examine whether the spatial component increases the models explanatory power to a significant degree. The LR is highly significant across all of the models with both QCO1 and QCO2 spatial weights, confirming the greater explanatory power when a spatially autoregressive component is included within the models (Anselin, 2004). In terms of the spatial diagnostics, the Wald[13] (W), LR test statistics, and the LM test statistics from the spatial diagnostics of each corresponding non-spatial OLS models follow the desired order, W>LR>LM, across all of the spatial models and indicates a satisfactory spatial specification. The explanatory power of the spatial models as a whole, in comparison with their OLS counterparts, reiterates the improvement in the models when using a spatial econometric approach. It can be observed that the Log Likelihood is greater and the AIC lower with the spatial models in comparison with the OLS models with both the QCO1 and QCO2 spatial weights; this would suggest the spatial models have more explanatory power and greater information content than the OLS models. Interestingly, the Log Likelihood appears to be maximised and the AIC minimised when QCO1 and not QCO2 spatial weights are used, which suggests that increasing the size of the neighbouring area considered in the spatial specifications detracts from the information 'content' of the models. As such, it can be argued that the spatial error models using QCO1 spatial weights are the preferred set of models.

The Breusch Pagan tests of SM1-SM10 suggest that heteroskedasticity is still an issue throughout the models, despite the inclusion of the spatially autoregressive component λ. Unfortunately, due to limitations in the available software, computation of

[13] The Wald (W) test statistic is the square of the z-statistic associated with the spatially autoregressive components in each of the spatial models (Anselin, 2004)

heteroskedasticity consistent standard errors was not possible using a ML estimation procedure. Whilst producing heteroskedasticity consistent standard errors was possible using a spatially weighted two stage least squares (2SLS) procedure, this estimation method would not produce the desired statistics pertaining to the explanatory power of the models. In order to surmount this issue, the ML estimates are presented here with the appropriate model statistics (Log Likelihood, AIC, LM test) and equivalent models using a 2SLS squares procedure with heteroskedasticity consistent standard errors can be found in the Appendix (A14). Fortunately, computing models with heteroskedasticity consistent standard errors makes very little difference to the statistical inference of the coefficient estimates, but nonetheless adds to the robustness of the ML results presented here.

The spatial error models using QCO1 spatial weights (Table 7.7, SM1-SM5) generally provides estimates that are broadly similar to their OLS counterparts. Perhaps the most important difference between models M1-M5 and SM1-SM5 is that the PSEMP variable appears to be sensitive to the inclusion of a spatial component. The estimated coefficients are reduced in all of the spatial models in comparison to their OLS counterparts, suggesting a bias in the OLS estimates that can perhaps be attributable to a spatial spillover i.e. some of the explanatory power of the PSEMP variable in the OLS models comes from the values of this variable in neighbouring locations. This somewhat weakens the inference that public administration and regulatory burdens act as a barrier to entrepreneurship. This is reaffirmed by the lack of significance observed on the estimated coefficients of the PSEMP variable in the spatial error models using QCO2 spatial weights (Table 7.8, SM6-SM10). A similar conclusion can be drawn regarding the significance of the estimated coefficients of the KRE variable; the estimated coefficients are only considered to be significantly different from 0 at a 90% confidence level in SM1 and SM2 and are insignificant in models SM3-SM5. However, this tendency is reversed through the use of the QCO2 spatial weights in SM6-SM10 where the KRE coefficients are highly significant. Thus, the inclusion of spatial components detracts only slightly from the inference that related knowledge leads to a greater amount of entrepreneurial opportunities that can be exploited by nascent entrepreneurs. Finally, it can be seen from SM1 and SM6 that the inclusion of the spatial components impacts the significance of the untransformed patent variable, AVPAT, which becomes significant at a 99% confidence level. Thus, the inference that greater regional knowledge, measured through regional patent intensity, encourages regional entrepreneurship is made more robust. In terms of the other explanatory variables, no qualitative difference is observed regarding the significance of any of the estimated coefficients, adding to the robustness of the results.

7.7 – ML Spatial Regression Models with Nearest Neighbour Spatial Weights

Table 7.9. Spatial lag models M1-M5 using 4NN spatial weights matrix. Dependent variable: LNFB1000. No. of observations = 408.

	SM11	SM12	SM13	SM14	SM15
Constant	0.032 (0.875)	0.238 (0.258)	0.231 (0.240)	0.312 (0.079)*	0.308 (0.047)**
Regional Patent Intensity (AVPAT)	0.141 (0.027)**				
Ln (Regional Patent Intensity) (LNAVPAT)		0.046 (0.001)***	0.046 (0.001)***	0.046 (0.00)***	0.045 (0.001)***
University Dummy (UNIDUM)	-0.075 (0.00)***	-0.072 (0.001)***	-0.066 (0.003)***	-0.072 (0.00)***	-0.065 (0.003)***
High Technology Manufacturing (HTM)	0.391 (0.383)	0.254 (0.571)	-0.049 (0.913)	0.275 (0.540)	-0.026 (0.953)
Knowledge Intensive Financial Services (KIFS)	0.290 (0.380)	0.251 (0.442)		0.266 (0.414)	
Knowledge Intensive High-tech Services (KIHTS)	-0.557 (0.108)	-0.536 (0.115)		-0.532 (0.118)	
Knowledge Intensive Market Services (KIMS)	1.136 (0.00)***	1.009 (0.001)***		1.023 (0.00)***	
Other Knowledge Intensive Services (OKIS)	-0.099 (0.683)	-0.030 (0.132)		-0.138 (0.562)	
Knowledge Intensive Services (KIS)			0.065 (0.691)		0.082 (0.609)
Related Knowledge Entropy (KRE)	0.226 (0.01)***	0.206 (0.018)**	0.115 (0.149)	0.200 (0.021)**	0.110 (0.163)
Unrelated Knowledge Entropy (KUE)	0.196 (0.005)***	0.173 (0.013)**	0.215 (0.00)***	0.150 (0.014)**	0.191 (0.00)***
Broad Industrial Diversity Index (HHI)	0.535 (0.576)	0.633 (0.505)	0.619 (0.522)		
Employment Density (EMPDENS)	0.00001 (0.02)**	0.00001 (0.005)***	0.00002 (0.00)***	0.00001 (0.005)***	0.00002 (0.00)***
Public Sector Employment (PSEMP)	-0.310 (0.277)	-0.233 (0.413)	-0.374 (0.193)	-0.179 (0.513)	-0.319 (0.246)
Claimant Rate (CLAIMRATE)	-0.056 (0.00)***	-0.054 (0.00)***	-0.055 (0.00)***	-0.055 (0.00)***	-0.055 (0.00)***
Median Incomes (INCOME)	0.0011 (0.00)***	0.0011 (0.00)***	0.0011 (0.00)***	0.0011 (0.00)***	0.0012 (0.00)***
Old Industrial Region Dummy (OIR)	-0.027 (0.168)	-0.030 (0.132)	-0.037 (0.065)*	-0.031 (0.118)	-0.038 (0.056)*
City of London Dummy (LONDUM)	0.776 (0.197)	0.777 (0.194)	0.642 (0.293)	0.801 (0.181)	0.665 (0.275)
W_LAG LNFB1000	0.328 (0.00)***	0.322 (0.00)***	0.328 (0.00)***	0.324 (0.00)***	0.329 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.814	0.839	0.832	0.839	0.832
Log Likelihood	213.047	216.158	207.338	215.937	207.134
AIC	-390.094	-396.316	-384.676	-397.874	-386.267
Wald Test	70.325	68.613	72.114	69.131	72.505
LM Test	70.547	70.327	71.872	71.387	72.681

Table 7.10. Spatial lag models M1-M5 using 8NN spatial weights matrix. Dependent variable: LNFB1000. No. of observations = 408.

	SM16	SM17	SM18	SM19	SM20
Constant	0.181 (0.359)	0.393 (0.057)*	0.359 (0.064)*	0.416 (0.017)**	0.381 (0.013)**
Regional Patent Intensity (AVPAT)	0.153 (0.015)**				
Ln (Regional Patent Intensity) (LNAVPAT)		0.048 (0.00)***	0.047 (0.00)***	0.048 (0.00)***	0.047 (0.00)***
University Dummy (UNIDUM)	-0.074 (0.00)***	-0.072 (0.00)***	-0.066 (0.003)***	-0.072 (0.00)***	-0.066 (0.00)***
High Technology Manufacturing (HTM)	0.283 (0.524)	0.147 (0.742)	-0.167 (0.709)	0.152 (0.731)	-0.161 (0.718)
Knowledge Intensive Financial Services (KIFS)	0.450 (0.169)	0.404 (0.211)		0.409 (0.204)	
Knowledge Intensive High-tech Services (KIHTS)	-0.555 (0.104)	-0.528 (0.114)		-0.527 (0.1150	
Knowledge Intensive Market Services (KIMS)	1.182 (0.00)***	1.048 (0.00)***		1.063 (0.00)***	
Other Knowledge Intensive Services (OKIS)	-0.155 (0.517)	-0.219 (0.359)		-0.211 (0.371)	
Knowledge Intensive Services (KIS)			0.054 (0.599)		0.089 (0.573)
Related Knowledge Entropy (KRE)	0.195 (0.025)**	0.174 (0.044)**	0.073 (0.354)	0.172 (0.046)**	0.072 (0.361)
Unrelated Knowledge Entropy (KUE)	0.186 (0.007)***	0.163 (0.019)**	0.220 (0.00)***	0.156 (0.010)***	0.213 (0.00)***
Broad Industrial Diversity Index (HHI)	0.088 (0.926)	0.196 (0.834)	0.177 (0.854)		
Employment Density (EMPDENS)	0.00002 (0.00)***	0.00002 (0.00)***	0.00003 (0.00)***	0.00002 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-0.368 (0.192)	-0.288 (0.306)	-0.448 (0.1160	-0.271 (0.315)	-0.432 (0.112)
Claimant Rate (CLAIMRATE)	-0.068 (0.00)***	-0.066 (0.00)***	-0.066 (0.00)***	-0.065 (0.00)***	-0.066 (0.00)***
Median Incomes (INCOME)	0.0009 (0.00)***	0.0009 (0.00)***	0.0010 (0.00)***	0.0009 (0.00)***	0.0010 (0.00)***
Old Industrial Region Dummy (OIR)	-0.017 (0.384)	-0.020 (0.315)	-0.028 (0.161)	-0.020 (0.308)	-0.028 (0.157)
City of London Dummy (LONDUM)	-0.358 (0.507)	-0.334 (0.533)	-0.499 (0.362)	-0.327 (0.512)	-0.492 (0.368)
W_LAG LNFB1000	0.348 (0.00)***	0.343 (0.00)***	0.342 (0.00)***	0.343 (0.00)***	0.342 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.840	0.843	0.834	0.843	0.834
Log Likelihood	219.103	222.357	212.210	222.335	212.193
AIC	-402.205	-408.714	-394.420	-410.670	-396.386
Wald Test	80.746	80.020	80.081	80.942	80.800
LM Test	89.342	89.050	89.406	90.923	91.036

An alternative approach to defining neighbours based on contiguity is to utilise a spatial weights matrix based on proximity by specifying the 4 and 8 nearest regions as neighbours. As indicated previously, the spatial diagnostics of the OLS models M1-M5 using the nearest neighbour's spatial weights matrices suggested the need for spatial lag specifications; the results of the models using a ML estimation procedure and a 4NN spatial weights matrix can be seen in Table 7.9, and the results of these models using a ML estimation procedure and a 8NN spatial weights matrix can be seen in Table 7.10. First, it can be seen that the spatial lag component is significant across all of the models and the Log likelihood and AIC statistics suggest a greater degree of explanatory power in comparison with their corresponding OLS non-spatial counterparts. Interestingly, the Log Likelihood and AIC of models SM11-SM20 also suggest that including a spatial lag component whilst using 4NN and 8NN spatial weights provides models with greater explanatory power than when a spatial error component and contiguity based spatial weights are used. Furthermore, when considering all of the models here, the Log Likelihood is maximised and the AIC minimised in the spatial lag models SM16-SM20 using 8NN spatial weights.

Unfortunately, due to software limitations, the LR test could not be computed with either a ML or 2SLS estimation procedure, such that the standard test of comparing the LR test statistic with the W and LM statistics could not be performed; however, comparing the W and LM test statistics suggests that the majority of the spatial models presented using 4NN and 8NN spatial weights would have failed the W>LR>LM test. Accordingly, this suggests that the use of contiguous spatial weights is preferred in this context. Furthermore, the software issues relating to the computation of heteroskedasticity consistent standard errors with the ML estimation method were also present in the spatial lag models with nearest neighbour spatial weights, and this shortcoming was dealt with in the same way. Models SM11-SM20 with 4NN and 8NN spatial weights using a 2SLS estimation procedure and heteroskedasticity consistent standard errors can be found in the Appendix (A15). The estimation of spatial lag models using a 2SLS procedure accounts for the endogeneity of the spatially lagged dependent variable by utilising Wx as instruments for Wy (Kelejian and Prucha, 1998; Kelejian and Robinson, 1993; Won Kim, Phipps and Anselin, 2003). As with the models SM1-SM10, their appears to be little substantive difference in the statistical inference of the estimated coefficients between the ML estimates presented here and the 2SLS estimates with heteroskedasticity consistent standard errors presented in the Appendix (A15).

In terms of the estimated coefficients on the explanatory variables, a similar pattern can be observed with models SM11-SM20 in comparison to their non-spatial counterparts M1-M5 as was observed with models SM1-SM10; namely, the estimated coefficient on the PSEMP variable loses significance across all of the models SM11-SM20; the estimated coefficient on the KRE variable loses significance in SM13 and SM15 when using 4NN spatial weights and in SM18 and SM20 when using 8NN spatial weights; finally, the estimated coefficient on the untransformed patent variable, AVPAT, is significantly different from 0 at a 95% confidence level in SM11 and SM16. However, one additional difference in the spatial lag models is that the estimated coefficient on the OIRDUM loses significance across the majority of the models presented, and can only be considered as significantly different from 0 at a 90% confidence level in SM13 and SM15. This does, of course, detract from the robustness of the inference that OIRs exhibit significantly lower firm birth rates even when controlling for other structural factors, due to the absence of a local entrepreneurial culture; however, the evidence presented supporting that inference is fairly comprehensive up until this point. In terms of the other explanatory variables, the statistical inference on the estimated coefficients remains the same as with the non-spatial OLS models M1-M5 and the spatial error models SM1-SM10, as does the interpretation of these statistics.

7.8 – Contextual Analysis

The regression results of the previous sections are relatively mixed regarding the relationship between knowledge and entrepreneurship as posited by the KSTE. There appears to be some evidence that supports the *Endogenous Entrepreneurship Hypothesis* and that entrepreneurship is significantly greater in contexts where there is greater investment in knowledge. Moreover, controlling for spatial autocorrelation through the inclusion of a spatial component in the regression models appears to somewhat affirm that the influence of knowledge on entrepreneurship is fairly ‘spatially bounded’, thus supporting the *Localisation Hypothesis*. This is evidenced by the estimated coefficients on the AVPAT/LNAVPAT, KIMS, KRE, and KUE variables that are significant in the OLS retaining significance throughout the spatial models. However, the lack of significance observed across the other knowledge variables (HTM, KIFS, KIHTS, OKIS) does not provide evidence in support of the *Endogenous Entrepreneurship* or *Localisation Hypotheses*, in that there does not appear to be a significant relationship between regional employment in these particular knowledge sectors and regional entrepreneurship. The significance of the coefficients on the KRE and KUE suggest that it might be the diversity of employment across these knowledge sectors, as opposed to the absolute employment in these sectors, that is the source of the greatest knowledge spillovers and Jacobian externalities that lead to a greater volume of entrepreneurial opportunities. The lack of significance on the HHI variable coefficients would imply, however, that these Jacobian externalities do not appear to apply across all industrial sectors. Interpreted with the EMPDENS variable, strong evidence is presented regarding the role of Jacobian externalities, knowledge spillovers, and their positive influence on the entrepreneurial process. Furthermore, the evidence presented supports several theoretical arguments regarding the relationship between incomes, unemployment and entrepreneurship. The OLS models provide tentative support for the *Barriers to Entrepreneurship Hypothesis,* at least when measured through employment in public administration and regulatory activities, in that the estimates of the coefficients of the PSEMP variable are significantly negative; however this result is sensitive to the inclusion of a spatially autoregressive component in the spatial models. Finally, the OIRDUM indicator variable suggests that OIRs exhibit significantly lower firm birth rates even when controlling for a variety of other structural factors, perhaps indicating the lack of a local entrepreneurial culture in these regions. This result is seen to be quite robust, retaining significance in the spatial models using contiguous spatial weights, but not when spatial lag models were implemented using nearest neighbour spatial weights. These results are now discussed within the context of the regional economy and with regards to their potential policy implications.

7.8.1 – Patent Intensity and Intellectual Property Rights

The positive relationship between regional patent intensity and firm births is quite robust, as the estimated coefficient is consistent and highly significant across all the models. What these results suggest is that regions with greater patenting of innovative ideas are also more entrepreneurial. Two different interpretations can be made regarding this relationship.

First, the relationship can be analysed through a prism that considers patents predominantly as a measure of knowledge output. The simple interpretation of this result is that regions that have a higher knowledge output can be expected to have higher firm birth rates and supports the first major hypothesis of the KSTE. Whilst that there is no way to determine whether these patents are filed by incumbent firms or by nascent entrepreneurs, the significantly positive coefficient would suggest the latter. Thus, a greater stock of knowledge creates a greater volume entrepreneurial opportunities, which causes higher firm birth rates in regions where knowledge outputs are highest.

Second, the positive and significant coefficient of the patent variable perhaps indicates the importance of intellectual property rights and related policy to the entrepreneurial process. By the UK's Intellectual Property Office's (UKIPO) own admission, patents "allow inventors to profit from their inventions" (UKIPO, 2013); such profit can be earned through the sale of the intellectual property rights, licencing the use of the invention covered by the patent, or, as is particularly relevant here, "discuss the invention with others in order to set up a business around the invention" (UKIPO, 2013). Clearly, the evidence presented here suggests that this third option, the birth of a firm, is a key way in which inventors and the holders of IP over such inventions decide to profit from their inventive activity.

What remains to be discussed is how securing IP rights through patenting might provide a sufficient incentive for entrepreneurial activity. Hughes (1988) presents the argument that the granting of IP rights is key to encouraging the "progress of science and useful arts." One of the possible reasons for this is that the incentive for either the firm or the individual to invest in the 'progress of science' depends crucially on the capacity to profit from that investment. IP provides a temporary monopoly rent that incentivises firms to invest in the creation of innovative knowledge. A proportion of this knowledge will spillover in the form of a new firm as posited by the KSTE.

However, the patenting activity of knowledge producing incumbent firms must be transparent and not overly complex if nascent entrepreneurs are to exploit un-commercialised knowledge in a KSTE context, as otherwise this would exert an additional cost burden on the entrepreneurial process. From a policy perspective, the results relating patenting activity to entrepreneurship have implications for recent work into 'patent thickets'. Shapiro (2001) defines a 'patent thicket' as "an overlapping set of patent rights requiring that those seeking to commercialise new technology obtain licenses from multiple patentees." In an environment where commercialised technology is becoming increasingly complex with greater patenting requirements per product, "would-be entrepreneur[s] or innovator[s] may face a barrage of infringement actions that [they] must overcome to bring [their] product to market" (Shapiro, 2001). These issues are pronounced and are causing 'a potentially dangerous' situation in the fields of biotechnology, semiconductors, computer software, and e-commerce. The potential for expensive litigation, as well as behaviour such as patent mining, the aggressive enforcement of patent rights, even against non-competitors, for financial reward, act as a 'tax' on "new products, processes, and even business practices" (Shapiro, 2001). This strict enforcement of IP legislation is imposing an unnecessary 'drag' on innovation through the creation of 'significant transaction costs' for entrepreneurs and innovators seeking to commercialise new technology; given the significance of IP in the entrepreneurial process shown in the models here, patent thickets and the practice of patent mining could act as a drag on entrepreneurship within the economy. Accordingly, national level policy regarding IP should consider the prohibitive effect on innovation posed by patent thickets and patent mining if ambitions to move towards a Knowledge Based Economy (KBE) centred on innovation and entrepreneurship are to be realised. In fact, the current UK government commissioned a review of IP policy in

November 2010 in order to determine whether existing policy met the demands of the 21st century economy (Hargreaves, 2011). Hargreaves (2011) finds that "some aspects of the way the system is currently working are a source of concern, because they appear to be causing barriers rather than incentives to innovation." These barriers are largely caused by the substantial volume of patents currently being filed, having the effect of vastly increasing transaction costs, particularly in markets that are 'patent sensitive'. Key recommendations to the government that can help alleviate the problem include:

- preventing the extension of patenting to business sectors where the incentive effect of patents is low compared with the overheads imposed
- resetting financial incentives for assessing whether to renew patents
- and ensuring that only high quality patents are granted (Hargreaves 2011)

This change in legislation should go some way to ensuring that patent thickets do not become increasingly prohibitive to the entrepreneurial process. Whilst 'patent thickets' are a larger problem on an industrial level as opposed to a spatial level, regions that have high employment in industries with significant 'patent thickets', such as biotechnology, are likely to experience a greater drag on regional entrepreneurship as a result. The regression results clearly suggest that securing IP rights through patenting is conducive to the entrepreneurial process and that this relationship has a clear spatial dimension; regions that have greater patenting activity tend to exhibit higher firm birth rates. It follows that 'patent thickets', in acting as a 'drag' on the appropriation of innovation through entrepreneurship, may affect some regions more than others. Overall, the positive influence that IP clearly has on entrepreneurship should provide a greater incentive for public bodies to ensure that IP policy does not become overly burdensome to the innovator or entrepreneur, as long term economic dynamism and growth are arguably dependent on the entrepreneurial tendency of the population.

7.8.2 – Universities and Employment in KBIs

A result that is perhaps a little disappointing as far as the KSTE is concerned is the non-significant effects of universities and employment in some of KBI sectors on regional entrepreneurship. In terms of the effect of universities, the consistently significant and negative estimated coefficient across all of the models presented suggests that the presence of a university actually detracts from the entrepreneurial activity in a region. This contradicts evidence from Audretsch and Lehmann (2005), for example, who find that universities have a positive influence on entrepreneurship within the paradigm stipulated by the KSTE. However, this might not necessarily detract from the postulates of the KSTE as far as universities are concerned. Instead it might just highlight that GB universities are particularly efficient at internalising the commercial returns of their research, such that there is little that can be appropriated by nascent entrepreneurs in the form of a new firm. Furthermore, it is possible that academics are more interested in the academic rather than the financial returns from their research; however this doesn't rationalise why the results are substantially different to Audretsch and Lehmann (2005). Of course, it is impossible to distinguish between these rationales, and indeed others, based on the regression results presented here, but the results do suggest that GB regions with a university tend to exhibit lower firm birth rates. It should also be remembered that attempting to measure the effect of universities on knowledge spillover entrepreneurship with a dummy variable might be considered a rather crude approach; the fact that the results do not corroborate with previous research, such as the more detailed approach of Audretsch and Lehmann (2005), perhaps suggests that the results presented here may not be reflective of the effect of universities on knowledge spillover entrepreneurship. Clearly the relationship between university research and knowledge spillover entrepreneurship is complex and further research, perhaps with a different methodological approach, is needed to shed more light on this relationship.

The insignificance of the estimated coefficients of the KBI employment variables, with the exception of the KIMS coefficient, presents little positive evidence supportive of the KSTE; this is also the case when the KIS sectors are aggregated into a single KIS variable. The most closely related study that utilises this approach to KBI sectors and entrepreneurship is Bishop (2012), who also found that an increased presence of HTM had no significant impact on knowledge spillover entrepreneurship. However, the results presented here regarding the influence of regional employment in KIS sectors on regional entrepreneurship contradict Bishop (2012), who finds that KIS employment positively effects regional entrepreneurship. One potential reason for this contradiction is that Bishop (2012) uses VAT registration data as his dependent variable, whereas this research uses the newer firm birth data from the Business Demography statistics, which is more comprehensive in its scope by also including firms newly registered for PAYE tax purposes. This data will therefore include firms whose turnover is lower than the £81000 threshold required for VAT registration (as of 2014); these firms may be less relevant as far as the KSTE is concerned as firms that are below this threshold are more likely to be less knowledge intensive. Furthermore, the lack of significance observed in the estimated coefficients of the HTM, KIFS, KIHTS, and OKIS variables might again be a methodological issue, as a disaggregated approach to KBI sectors might require a disaggregated approach in the measurement of firm births for use as a dependent variable as a dependent variable i.e. by decomposing the firm birth variable into firm birth in more relevant knowledge sectors. This approach was utilised by Audretsch and Keilbach (2007) who find that regional R&D intensity has a positive effect on entrepreneurship with High Technology and ICT sectors, but not across all sectors in the form of 'general' entrepreneurship. This is connected to the discussion regarding the 'relatedness' of knowledge, in that it is perhaps plausible that sector specific knowledge generates entrepreneurial opportunities within the sectors where that knowledge is produced, i.e. knowledge is more likely to spillover in the form of a new firm within sectors rather than between sectors. This is clearly an area for further research, and decomposing the dependent variable both spatially and by industrial sector will meet this end.

Despite these mixed results and methodological limitations, the regression results suggest that greater regional employment in KIMS results in greater entrepreneurial activity, a result that is consistent and robust across spatial models. On closer inspection, the KIMs variable incorporates employment across sectors that are primarily concerned with the efficient and effective running of businesses. For instance, this includes employment in the division ‘70: Activities of head offices; management consultancy activities’. Greater regional employment in this sector may result in a regional stock of knowledge that is particularly conducive to the effective running of an organisation and local nascent entrepreneurs may benefit from having greater access to this knowledge through local networks and the local labour market. For example, people leaving employment in this sector to start their own firm might perhaps be more confident about how to run an effective organisation due to their experience and knowledge gained within this sector, and thus less uncertain about the potential for success in their new venture. Whilst this is conjecture, the consistency and robustness of the results regarding the effect of employment in KIMS on entrepreneurship suggests that this might be a fruitful area for future research. This research could involve a different methodological approach that investigates the employment backgrounds of entrepreneurs and how this influenced their decision to start a new venture. This is similar Shane’s (2000) approach, which looked at how different experiences influenced peoples’ perception of potential opportunities to exploit a particular innovation; it might be posited that the knowledge of how to effectively run an organisation forms an important part of the decision to behave entrepreneurially and undertake a new venture.

7.8.3 – Diversity and Agglomeration externalities

The regression analysis takes two approaches to sectoral diversity, first by analysing the diversity of employment across knowledge sectors as in Bishop (2012) (KUE, KRE), and secondly by taking a broader approach that considers diversity of employment across all sectors (HHI). The results suggest that employment diversity between knowledge sectors (KUE) and employment diversity within knowledge sectors (KRE) are both conducive to local entrepreneurship. This corresponds with the results of Bishop (2012) and Bae and Koo

(2008), even though these studies use a different dependent variable. According to the results presented here, the impact of economic diversity on the creation of entrepreneurial opportunities only appears to extend across knowledge sectors; the HHI variable is insignificant across all models, showing no indication of the presence of either MAR or Jacobian externalities. This is in contrast to both Audretsch, Dohse and Niebuhr (2010) and Audretsch and Keilbach (2008a), who find that the presence of MAR externalities provides greater entrepreneurial opportunities and that broad sectoral diversity has a negative influence on regional entrepreneurship. However, that diversity across knowledge sectors is seen to exhibit a significant and positive effect on entrepreneurship, where broader diversity does not, is perhaps to be expected. The high propensity of knowledge to spillover (Arrow, 1962b) suggests that it is these KBI sectors that might exhibit local externalities resulting from knowledge spillovers to the greatest extent, thus creating more entrepreneurial opportunities. Furthermore, the robustness of the KUE estimates supports Bishop's (2012) observation of Bae and Koo's (2008) argument regarding related knowledge, discussed on Page 166, and one of the central tenets of the KSTE regarding uncertainty and incumbent conservatism (Audretsch and Lehmann, 2005); the results would suggest that the more uncertain the regional knowledge stock, the more opportunities will be exploited by entrepreneurs and not incumbents.

Interpreting the significance of the KUE and KRE variables within the context of urbanisation economies and the presence of Jacobian externalities should be done in conjunction with the EMPDENS variable, which measures the extent to which agglomerative effects influence the entrepreneurial process. The results suggest that general agglomeration externalities exert a positive influence on local entrepreneurial activity, i.e. firm birth rates are higher in regions that exhibit a greater employment density. This effect is consistent across all models and robust regardless of spatial specification and the use of heteroskedasticity consistent standard errors. Interestingly, the estimated marginal effect of the EMPDENS variable appears to decrease in the spatial models and when the sizes of the neighbouring areas are increased using QCO2 and 8NN spatial weights. This suggests that some of the estimated marginal effect observed in the OLS models can be attributed to a spatial spillover; this is perhaps to be expected, as urban areas generally comprise regions that have a similarly high employment density, as suggested by the Moran scatterplot showing the logarithmic transformation of EMPDENS (Appendix: A16).

Relating to diversity itself, Jacobs (1969) argues that industrially diverse urban centres are key to the realisation of urbanisation economies, due to the "exchange of complementary knowledge across diverse firms and economic agents within geographic regions" (Feldman, 1999). The regression results suggest that this holds across KBIs, such that the urbanisation economies realised across KBIs are a key driver of the entrepreneurial process, and this process is enhanced by a greater proximity in employment within these KBIs.

Previous literature examines the impact of localisation or urbanisation economies on productivity or growth, with results that are generally mixed (Feldman, 1999). For example, Henderson (1986, cited in Feldman 1999) finds that localisation economies tend to increase factor productivity, whereas Glaeser*, et al.* (1992) find that localisation economies have little beneficial impact on the growth of cities, instead finding that a diverse industrial base promotes growth over time. However, it is perhaps logical that urbanisation economies resulting from economic diversity would exert a greater influence on entrepreneurship vis-à-vis firm births than on other economic metrics. As Feldman (1999) indicates, urbanisation economies are concerned with the concept of cross product increasing returns – "one activity increases the marginal product of another activity and [this] effect is greater with proximity" (Feldman, 1999). If a given activity is seen to make other activities potentially more profitable, then astute entrepreneurs may be drawn into these other activities in order to capitalise on a potentially profitable opportunity; this may manifest itself in the birth of a new firm. Furthermore, from a theoretical perspective, diverse economic agglomerations may reduce search costs and "increase the opportunity of serendipitous events that that would provide innovative opportunities" (Feldman, 1999). Two inferences can be made with regards to this second context. First, the reduction of search costs through the agglomeration of people and services might enable astute entrepreneurs to become aware of opportunities quicker and with less difficulty; this perspective is supported by the positive influence employment density has on firm birth rates. Second, increasing the probability of 'serendipitous events' will provide an increased set of innovative opportunities, made more likely by the exchange and combination of diverse yet complementary knowledge into innovative opportunities; these opportunities could then be appropriated through the creation of a new firm by an entrepreneur, as opposed to within existing organisational structures. The observed significant effect of economic diversity and employment density on firm birth rates would indicate the importance to the entrepreneurial process of cross product increasing returns, a reduction of search costs, and the increasing likelihood of the creation of innovative opportunities, within the context of urbanisation economies and Jacobian externalities.

7.8.4 – Barriers to Entrepreneurship

Results that were slightly less consistent regarded the relationship between firm births and barriers to entrepreneurship measured by proxy utilising regional employment in public administration activities. This proxy has precedence throughout the empirical literature (e.g. Acs, *et al.*, 2009), despite the apparent need for a greater consideration of what can be considered a 'barrier to entrepreneurship'. For example, anything that has a negative impact on entrepreneurship may be considered a 'barrier' from a semantic perspective, such that establishing how this might manifest itself as a defined, economic reality is troublesome. The main reason why this proxy was used was largely pragmatic, as it was difficult to find other measures that were consistently available at the spatial level analysed and that also exhibited significant spatial variation to warrant inclusion.

Possibly because of these issues, the evidence supportive of the hypothesis that public sector administrative employment acts as a barrier to entrepreneurship and negatively affects firm birth rates was fairly weak. The OLS models M1-M5 show that the estimated coefficient on the public sector employment variable is negative and significant in four of the five models; however, the inclusion of a spatial component in all of the spatial models appeared to nullify the significance of this effect. Furthermore, the estimated marginal effect of public administration employment is also reduced across these spatial models; this suggests that an element of the marginal effect estimated in the OLS models M1-M5 can be attributed to a spatial spillover from the burden of public administration employment in neighbouring regions. Above all, this reinforces the need to utilise spatial econometric methods when conducting analyses on spatial data of this nature, as incorrect inferences can be made with the estimates if these econometric procedures are not followed.

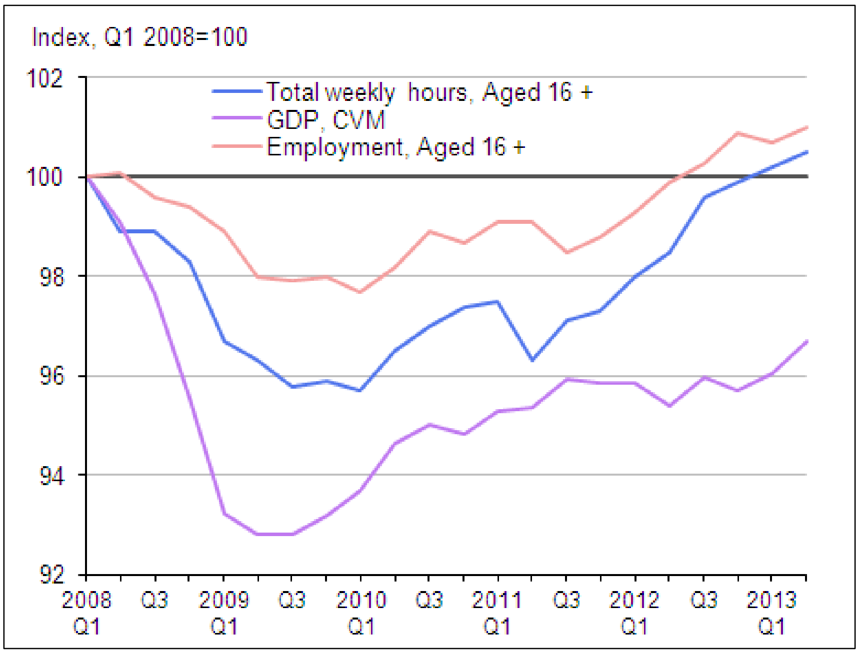
That the estimated coefficient on the PSEMP variable is insignificant across the majority of the models contradicts the results of Acs*, et al.* (2009) using similar measures of government intervention. The significance of the OLS results in isolation would imply that administration related activities and regulatory burdens appear to act as a significant cost to nascent entrepreneurs. The clear implication of this result would be that if public bodies wish to encourage entrepreneurship and enterprise, then reducing the administrative burden of the public sector is a feasible way to meet that end. However, the results of the spatial models impede this interpretation and associated policy advice. Two related reasons for the lack of significance observed on the estimated coefficients can be offered. First, it could just be that entrepreneurs throughout GB do not perceive the cost imposed by local administrative and regulatory burdens as sufficient to deter entrepreneurship. Second, the proxy variable used to measure public administrative and regulatory 'barriers to entrepreneurship' does not adequately quantify local 'barriers'. Theoretically, the relationship between these forms of administrative barriers and entrepreneurship is logically valid, such that it is reasonable to suggest that the lack of significance observed might be due to the inadequacy of the variable used here. This is a methodological issue that could possibly be rectified through further research that uses an alternative methodological approach.

7.8.5 – Unemployment and Entrepreneurship

An interesting and consistent relationship found throughout the regression analysis is the apparent negative causal relationship between unemployment and entrepreneurship; the results consistently suggest that firm birth rates are significantly lower in sub regions with greater unemployment. The minimal impact spatial considerations have on either the magnitude of the estimated coefficient or its significance would appear to suggest that this relationship is fairly localised, with little observable influence of a spatial spillover from neighbouring sub-regions. This could perhaps suggest that pessimism from local unemployment issues may have a greater influence than the interpretation of wider regional or national economic issues.

This negative relationship was also found by Audretsch and Keilbach (2007) in High-technology and ICT industries, as well as Bishop (2012) in his analysis of GB regions. From a theoretical perspective, this may appear to contradict the view of unemployment representing a low opportunity cost to entrepreneurship in theories that consider entrepreneurship in the context of occupational choice models (Kihlstrom and Laffont, 1979), or theories where individuals can be 'pushed' into entrepreneurship (Moore and Mueller, 2002). The empirical results of Evans and Leighton (1989) are also contradicted, as they suggest that the tendency to partake in entrepreneurship is encouraged when unemployed; namely that "people who tend to switch from wage-work to self-employment tend to be people who... [experience] relatively frequent or long spells of unemployment as wage workers" (Evans and Leighton, 1989:532). Here, entrepreneurs balance the opportunity cost of entrepreneurship, forgoing a 'certain' wage, against the 'risky' profit of entrepreneurship; hence, sub-regions with greater unemployment should perhaps represent sub-regions with a generally lower opportunity cost to entrepreneurship and a positive relationship between unemployment and firm births would be observed. However, contesting this theoretical perspective with the use of the results from the regression analysis here is perhaps slightly misguided. The use of claimant count data to proxy unemployment, for reasons discussed earlier, represents the proportion of unemployed who receive JSA; thus, the negative relationship observed may suggest that unemployment benefit significantly dis-incentivises entrepreneurial behaviour. Of course, this should not be construed as a recommendation to lower unemployment benefit due to its potentially detrimental effect on entrepreneurial drive, as there are arguably more plausible explanations of the negative relationship. For instance, the time period analysed in this thesis cover a period of time in GB characterised by a substantial contraction in output as a result of the recent financial crisis (ONS, 2013). Figure 7.2 illustrates the magnitude of the fall in output, employment, and hours worked over the data period, such that the results obtained may not accurately represent the long term relationship between unemployment and entrepreneurship.

Figure 7.2. Index of output, employment, and hours since 2008, seasonally adjusted



Source: ONS, 2013

Furthermore, it is possible that this recent recessionary period, and the associated pessimism that accompanies such recessions, has had a detrimental effect on entrepreneurial drive within the economy. Regions that have experienced the largest reduction in output and employment would perhaps have the most pessimistic outlook on economic prospects, thus discouraging potential entrepreneurs from starting a new business venture. This is, of course, a slight variation on the theory discussed earlier that unemployment can be a signal of poor local demand and could potentially discourage potential entrepreneurs, which, according to the results, appears to provide a plausible theory for the perceived negative relationship. Alternatively, as Bishop (2012) suggests with similar results, high unemployment might make it more difficult for entrepreneurs to source finance for a new venture; this is related to how financial constraints impact entrepreneurship and the positive relationship observed on the INCOME variable.

Moreover, a number of forces that affect the relationship between unemployment and entrepreneurship might exist concurrently. For example, in occupational choice models of entrepreneurship suggesting that entrepreneurs consider a certain wage against a risky profit (Kihlstrom and Laffont, 1979), the risk element comes from the need to associate a probability with a given level of profit from a new venture[14]. Logically, if an entrepreneur is surrounded by high unemployment, their judgement of the likelihood of a given level of profit from a business venture may fall i.e. the expected profit will decrease, making the option of a certain wage more attractive and thus lowering firm birth rates. Alternatively, those who are unemployed might still be driven to entrepreneurship by poor paid employment opportunities (Moore and Mueller, 2002), thus suggesting that entrepreneurship may be positively associated with unemployment. If both conditions are said to exist, then the negative coefficient might suggest that the former relationship dominates the latter; specifically, that higher unemployment lowers an entrepreneur's expectation of potential profits and dominates the push into entrepreneurship from poor employment opportunities. Whilst this is somewhat speculative, it serves to illustrate that the empirical relationship between unemployment and entrepreneurship is complex and deserving of further research. For example, a longitudinal approach that analyses the development of the relationship between unemployment and entrepreneurship over time, as opposed to the cross-sectional, spatial analysis conducted here, would be appropriate to

[14] There is a wider philosophical debate in Knights (1921; 2006) discussion of uncertainty and risk as to the extent that people can make these probabilistic estimates. Nevertheless, the nature of the relationship considered here, that unemployment will lower people's expectations or probabilities of suitable profits, still stands regardless of whether or not people can precisely make these probabilistic judgements.

assess the dynamic nature of this relationship between unemployment and entrepreneurship. Such an approach is advocated by Cowling and Mitchell (1997), who argue that a temporal dimension is needed as the duration of unemployment is shown to significantly affect one's proclivity to become self-employed.

7.8.6 – Incomes, Financial Constraints, and Entrepreneurship

The estimated effect of regional incomes on entrepreneurship is similarly unambiguous based on the results presented here. The positive and significant coefficient across all of the models presented provides support to the hypothesis that larger regional incomes approximate a greater availability of finance (e.g. Bishop, 2012) as opposed to a greater opportunity cost to entrepreneurship (e.g. Kihlstrom and Laffont, 1979). The OLS results would suggest that a £100 increase in regional weekly median incomes would tend to cause a 15% increase in the firm birth rate, *ceteris paribus*. The spatial error models have similar literal interpretations, suggesting that a £100 increase in regional weekly median incomes will tend to cause an 11%-13% increase in the regional firm birth rate, *ceteris paribus*. The consistency and robustness of these results provides fairly strong evidence that high income levels are conducive to entrepreneurship. This is broadly supportive of the findings presented by Bishop (2012), despite using a different dependent variable. The empirical results of Evans and Jovanovic (1989) also have a similar inference, namely that "liquidity constraints bind… [and] wealthier people are more likely to become entrepreneurs."

Thus, these results provide evidence that generally supports the concept that potential entrepreneurs with higher incomes face fewer financial constraints, possibly through the availability of greater amounts of start-up capital through saving and the greater provision of collateral for borrowed finance. This is in contrast to the concept that higher incomes represent a higher opportunity cost to entrepreneurship. This does not discount the theoretical validity of occupational choice models that consider wages as an opportunity cost (Kihlstrom and Laffont, 1979), merely that no evidence is found for it in the regression results presented here. For example, Evans and Leighton (1989) provide empirical evidence that high income may discourage entrepreneurship, in that "people who tend to switch from wage-work to self-employment tend to be people who receive relatively low wages". However, contrasting the results here with those of Evan and Jovanovic (1989), in terms of how both incomes and unemployment are related to entrepreneurship, serves to illustrate the complex nature of 'push' factors influencing entrepreneurial behaviour. The use of self-employment to measure entrepreneurship is one such fundamental difference between Evans and Leighton's (1989) study and this study, as the determinants of the decision to become self-employed may differ substantially from the determinants of the decision to start a firm in a KSTE context.

Nonetheless, the regression results here have at least one clear policy implication, in that by allowing people a greater opportunity to accumulate savings and collateral for use as start-up capital through increasing net-incomes may encourage entrepreneurial activity. This may be intimately linked to how tax burdens can act as a barrier to entrepreneurship. In fact, there is a growing body of literature that examines the relationship between forms of taxation and how this might influence entrepreneurial activity through the provision of greater start-up capital. For instance, Cagetti and De Nardi (2007) use a theoretical model to argue that eradicating the estate tax, accompanied with other particular fiscal policies, in the US may lead to slight increases in aggregate output and accumulated capital, by relaxing financial constraints for potential entrepreneurs. Similarly, Kitao (2008) attempts to disentangle the forces that influence aggregate variables, factor prices, wealth distribution, and welfare with fiscal policies that utilise "flexible forms of taxation that distinguish between sources of income." The results of Kitao's (2008) entrepreneurial choice model suggest that "reducing the tax burden on entrepreneurs encourages their entry into business and effectively increases the investment by the most productive entrepreneurs." Moreover, it is suggested that reducing tax on capital income is effective in increasing output, but more so when entrepreneurial investment in targeted specifically. Both of these studies hint that reducing tax burdens gives nascent entrepreneurs greater access to start-up capital, and this 'access to capital' argument is reflected in the results presented here; namely, the regression results suggest that higher regional incomes encourage regional entrepreneurship through reflecting fewer resource constraints faced by latent local entrepreneurs. The business cliché suggests that one must 'speculate to accumulate', these insights regarding how financial constraints constrict entrepreneurship might instead suggest that one must 'accumulate to speculate' first.

7.8.7 – OIRs and Local Entrepreneurial Culture

Finally, a strong finding throughout the models is that OIRs appear to exhibit significantly lower firm birth rates. The OIR dummy was negative and significantly different from 0 at a 99% confidence level in the OLS models M1-M5 and the spatial error models SM1-SM10; however, the estimated coefficient generally loses its significance in the spatial lag models of SM10-SM20. These results are also robust across models using heteroskedasticity consistent standard errors (Appendix: A14-15). Given that this result is statistically significant even when controlling for a myriad of other structural factors might indicate that OIRs lack the requisite entrepreneurial culture for reasons discussed extensively in the previous chapter.

Hofstede (1984) describes culture as a "collective programming of the mind that distinguishes the members of one group or category of people from another" (cited in Hayton and Cacciotti, 2013:709). In the context of entrepreneurial culture, Hayton and Cacciotti (2013) extend this by specifying culture as "the values, beliefs and expected behaviours that are sufficiently common across people within (or from) a given geographical region as to be considered as shared"; furthermore, entrepreneurial behaviour is said to be "facilitated both by formal institutions and by socially shared beliefs and values that reward or inhibit the necessary behaviours" (Hayton and Cacciotti, 2013:709). Accordingly, there is a branch of research that analyses the impact of culture on regional or national levels of innovation or new firm formation, considering culture as a "multidimensional phenomenon whose constituent parts interact to create the whole" (Williams and McGuire, 2010); here, culture is considered as a single variable reflecting the three cultural dimensions of power proximity, uncertainty acceptance, and individualism (Hayton and Cacciotti, 2013). The OIRs of GB provide a particularly interesting example of the potential role of individualism as an important dimension of local entrepreneurial culture. As discussed in the previous chapter, one aspect that characterised OIRs throughout the nineteenth and twentieth century was a high presence of coal mining and heavy industry. This industrial context was characterised by large production plants with significant scale economies and a highly unionised labour force (Birch, MacKinnon and Cumbers, 2010); the latter is particularly relevant when considering the role of individualism as a dimension of entrepreneurial culture. The mechanism through which trade unionism might harm the individualism necessary for entrepreneurial behaviour, within the context of entrepreneurial culture, is deserving of greater exploration.

As Banks (1974) highlights, one of the key features of the trade union movement is the trade union as an instrument of collective bargaining. This collective bargaining role is considered the trade union's 'main function', serving to protect the interests of union members against employers. The principles of collectivism lie at the heart of the trade union movement and can be contrasted directly with the principles of individualism: "what trade unionism primarily represents is a rejection of the theory of economic individualism, characteristic of the capitalist epoch in the classical phase" (Banks, 1974:77). This 'rejection of economic individualism' then manifests itself in the 'substitution of economic individualism in favour of collective decision-making' (Banks, 1974:119). Thus, a high presence of trade union membership, with its emphasis on 'collective decision making', might supplant the individualist decision making that is typically considered as an important dimension of entrepreneurial culture.

These insights might find some place in the psychology based approaches to entrepreneurship discussed in Chapter 4 Section 4.2, in that they emphasise how social acceptance of certain psychological attitudes can influence a person's proclivity for entrepreneurship. The idea that culture is a 'collective programming of the mind', comprising "socially shared beliefs and values that reward or inhibit the necessary behaviours" (Hayton and Cacciotti, 2013: 709) also alludes to the importance of a 'socially shared psychology' in determining entrepreneurial behaviour. Furthermore, the significance of the OIR variable highlights the importance of controlling for a local entrepreneurial culture and social capital in KSTE research, something that is lacking in some of the previous research discussed in Chapter 4 Section 4.4 (Acs*, et al.*, 2009; Audretsch and Keilbach, 2007; Bishop, 2012). For example, and with reference to Banks (1974), controlling for a lack of entrepreneurial culture could be achieved by including regional trade union membership, as a proportion of the total regional labour force, as an explanatory variable. Of course, other approaches looking to measure and control for local entrepreneurial culture is made difficult by the fact that many of the components of culture are unobservable and embodied in the error term in a linear regression model. However, this reemphasises the importance of using spatial econometric methods, and in particular spatial error models, as this will allow these unobservable phenomena to vary over space.

Due to the dismantling of the coal industry in GB from the 1980s onwards, the effect of the collectivist ethos of trade unionism on entrepreneurial culture only holds as a plausible explanation for lower firm birth rates if this form of culture persists over a long time period. Several pieces of research suggest that this may indeed be the case. Culture in this context can be seen as a type of 'informal institution', "informal (i.e. unwritten) norms of conduct that individuals follow in their day-to-day conduct". Moreover, these "informal rules are difficult to influence, at least in the short run" (Sautet, 2005). Informal institutions are therefore subject to what Martin and Sunley (2006) refer to as 'Institutional Hysteresis', the tendency for institutions, social interactions and norms to be self-replicating over time. Fritsch and Wyrwich (2012) argue that this is particularly the case for informal institutions and that these are a critical aspect of a local entrepreneurial culture. Thus, it is arguable that local entrepreneurial culture, as an informal institution, persists over time and that the OIRs of GB may still be experiencing the adverse effect of the collectivist decision making nature of trade unionism on their local entrepreneurial activity.

Whilst there might be other factors involved, the fact that the OIR dummy is highly significant, even when controlling for a myriad of other factors, provides compelling evidence that a lack of local entrepreneurial culture significantly inhibits regional entrepreneurial activity. Whether this is robust when other demographic factors are considered remains to be seen, and this will be investigated in the next chapter. Furthermore, possible future research could assess whether this finding is replicated using European wide data, as there are several regions across western Europe that are also characterised as OIRs (Birch, MacKinnon and Cumbers, 2010) that may also exhibit significantly lower firm birth rates when controlling for other structural factors.

7.9 – Conclusion

This chapter has sought to establish whether the production of explicit (scientific, codified) knowledge can be seen to create opportunities that are appropriated for profit by astute entrepreneurs, within the context stipulated by the KSTE. This research has built on existing research through the utilisation of newly available data for GB, whilst applying spatial econometric techniques that are lacking in some previous research. The motivation for the application of spatial techniques was primarily to investigate whether results from previous research are substantially different when controlling for spatial spillovers across observations, as well as trying to disentangle some of the spatial interactions. The results of the spatial regression analysis are somewhat supportive of previous KSTE related research showing that the production of knowledge creates entrepreneurial opportunities appropriated by nascent entrepreneurs and these opportunities are spatially bounded (Acs, *et al.*, 2009; Audretsch and Keilbach, 2007; Audretsch and Lehmann, 2005).

The results suggest that regions endowed with more knowledge exhibit greater firm birth rates; this inference mainly stems from the significantly positive coefficients on regional patent intensity. An additional conclusion that can be drawn from the significance of the patent variable is that securing intellectual property rights on potentially profitable innovative ideas is an important component of the entrepreneurial process. However, there appears to be little evidence that employment in in KBIs is conducive to entrepreneurship. The exception to this is that increased regional employment in knowledge intensive market services (KIMS) has a significantly positive effect on regional firm birth rates; a potential explanation for this is that a regional knowledge stock constituting knowledge regarding the effective operation of businesses reduces the uncertainty faced by nascent entrepreneurs and encourages their entrepreneurial behaviour.

Furthermore, diversity across these knowledge sectors, both in an unrelated and related form, appears to be particularly conducive to entrepreneurial activity, being positively associated with regional firm birth rates across the majority of the models. This knowledge diversity appears to encourage the prevalence of Jacobian externalities, as the spillover of knowledge between firms in this Jacobian context appears to generate a greater volume of entrepreneurial opportunities. When compared to the lack of significance in the KBI variables, this suggests that it is the diversity of employment across KBIs, as opposed to absolute employment in KBIs, which encourages knowledge based entrepreneurship in a KSTE context due to the presence of Jacobian externalities. These effects are further enhanced if employment within these industries is proximate, evidenced by the positive coefficient on the employment density variable, as this increases the chances of serendipitous events and local network externalities that further encourage the spillover of knowledge. However, no evidence is presented suggesting that Jacobian externalities exist across all industrial sectors; that Jacobian externalities exist across KBIs and not all industries is perhaps testament to the greater propensity of knowledge to spillover between firms in comparison with other factors. In terms of the remaining tenet of the KSTE, it is shown that administrative and regulatory barriers from the public sector can have a detrimental effect on the entrepreneurial process. However, this is only applicable to the non-spatial models, as the inclusion of a spatial component appears to reduce the estimated effect of this variable, suggesting that spatial spillovers are the cause of the significantly negative coefficient of the public sector employment variable in the OLS models.

Evidence is also presented that shows the negative effect of regional unemployment on firm birth rates; reasons for this could include the detrimental effect that the pessimism surrounding poor economic performance has on the entrepreneurial process and expectation of potential profits, as well as an increase in the financial constraints faced by regional populations characterised by greater unemployment. A similar inference is made regarding the effect of regional incomes on firm birth rates, as consistent evidence is found that regions with a higher median income are more likely to exhibit higher firm birth rates, *ceteris paribus*. Again, this result suggests that regions with higher incomes face fewer financial constraints and a greater availability of start-up capital, encouraging local entrepreneurial activity. Finally, it can be seen that OIRs have significantly lower firm birth rates even when controlling for other structural factors. One potential reason for this is that OIRs were home to industries characterised by a strong trade union presence, which had a negative impact on the individualism that is a crucial dimension of local entrepreneurial culture.

Overall, the analysis of this chapter provides evidence that is supportive of the main tenets of the KSTE with regards to explicit knowledge and regional entrepreneurship. What remains to be seen is whether tacit (embodied) knowledge and entrepreneurial ability gained through education and experience also has a similar influence on the entrepreneurial process. It also remains to be seen whether controlling for a range of demographic factors influences the inference of the estimated effects of the control variables. This will provide the basis for the next chapter.

8

Chapter 8 – Tacit Knowledge, Human Capital, and Entrepreneurship: A Spatial Analysis of Great Britain 2008-2010.

8.1 – Introduction

The previous chapter investigated the empirical relationship between explicit knowledge and entrepreneurship within the paradigm stipulated by the KSTE, showing a pattern whereby regions that produce more knowledge can be expected to exhibit greater firm birth rates. However, this is just one side of the possible dynamic between knowledge and entrepreneurship, the other being the dynamics between embodied (tacit) knowledge, entrepreneurial ability, and entrepreneurship which were discussed extensively in Chapter 4, Section 4.5.

There is a well-established dichotomy within economic theory that contrasts 'codified' knowledge against its embodied counterpart 'tacit' knowledge (Cowan, David and Foray, 2000). Throughout this chapter, tacit knowledge will be considered to comprise the unique, idiosyncratic knowledge embodied within individuals that cannot be easily transferred between people. In an entrepreneurial context, this is closely related to the concept of entrepreneurial ability, a specific form of human capital required to deal with economic disequilibria that is enhanced by education and experience (Schultz, 1975; 1980). There are also similarities with the concept of 'Prior Knowledge' as described by Shane (2000). The main premise resulting from this work is that individuals possess certain cognitive attributes and attitudes that are important to the entrepreneurial process and the discovery of entrepreneurial opportunities, and that these attributes are enhanced by education and experience.

Investigating how these factors may influence entrepreneurship is thus an important aspect of entrepreneurial research. Accordingly, the purpose of this chapter is to analyse how the presence of these cognitive attributes and attitudes across regional populations influence entrepreneurial activity in a spatial context. In order to do so, this chapter will utilise the same spatial econometric techniques and Business Demography data regarding the 408 pre-2009 LADs of GB from 2008-2010 as the previous chapter. This is arguably a more traditional approach to entrepreneurship research, in that it assumes an exogenously existing opportunity that is recognised by entrepreneurs who possesses certain cognitive attributes or attitudes. Furthermore, in terms of the geography involved, tacit knowledge, entrepreneurial ability, and entrepreneurship may show a different spatial dynamic such that it is deserving of greater investigation. This different dynamic will come from the fact that the spatial distribution of tacit knowledge and human capital will be based on a person's place of residence as opposed to their place of employment, which was the focus of the previous chapter. Furthermore, this difference may be enhanced further by the different manner in which tacit knowledge diffuses over space (Döring and Schnellenbach, 2006).

8.2 – Empirical Model

The methodological approach of this chapter will be identical to the approach of Chapter 7. A number of linear regression models will be specified using LNFB1000, regional firm births per 1000 of the regional population of working age, as the dependent variable. This will be regressed against explanatory variables denoting the educational attainment of a regional population, a range of regional demographic factors, and a series of controls similar to the previous chapter. OLS estimation will be used for the non-spatial linear regression models to assess the various marginal effects of the explanatory variables, followed by several tests on the residuals from the models to identify heteroskedastic and spatial autocorrelation issues. Lagrange Multiplier (LM) tests will be computed to test for spatial dependence issues, which will be controlled for using a spatial lag model, or for the presence of spatial heterogeneity, which will be corrected for using spatial error models. Different spatial weights, in terms of level of contiguity and distance, will be used to determine the extent to which these spatial issues persist. Should heteroskedasticity be present in the residuals after the computation of these models, as indicated by the diagnostic testing, adjusted standard errors will be used. The OLS linear regressions, spatial lag and spatial error models will be of the general function forms outlined in Section 7.2 of the previous chapter.

8.3 – Measurement and Descriptive Analysis of Explanatory Variables

8.3.1 – Human Capital and Education

In order to assess the effect of the spatial distribution of human capital on spatial variations of firm birth rates, it is useful to briefly discuss the economics literature regarding the locational choices of people endowed with high levels of human capital. To begin with, it is important to note that 'knowledgeable people are not evenly distributed in geographical space and that labour migration, augmented by changes in economic growth, constantly changes the map of human capital' (Storper and Scott, 2009). In making migratory choices, people endowed with high levels of human capital assess the potential returns from their human capital against the cost of migration. These returns to human capital may vary across space, but in general net migration flows of people endowed with high levels of human capital are towards areas with higher nominal wages (Faggian and McCann, 2006). From another perspective, Storper and Scott (2009) state that "individuals choose to locate on the basis of some sort of structured match between their talents and forms of economic specialisation and labour demand to be found in the places where they eventually settle". Specifically, the likelihood that an individual residing in a region will relocate is an increasing function of the present value of potential moves from that region. The possibility, or relative attractiveness, of migration depends crucially on spatial variations in regional employment opportunities and this, perhaps unsurprisingly, is related to the economic dominance of London (Faggian and McCann, 2006; Sjaastad, 1962).

What is perhaps more interesting is the way in which this spatial distribution of human capital changes, or persists, over time. By way of an example, Great Britain has been seen to exhibit interregional nominal wage differences of 40% between the highest and lowest regions, whereas productivity differs by 100% between the highest and lowest regions (Faggian and McCann, 2006). Despite these rather large inequalities, migration flows are too weak to correct for this and these differences persist. The nature of these continued inequalities might suggest that there are significant positive externalities in the form of increasing returns to scale on a regional level due to spillovers within the agglomeration of educated, creative, and talented individuals. Round after round of 'path dependent urban expansion' occurs through circular and cumulative causation where growth in output expands the local labour market, which then encourages yet more output growth through the 'home market effect' and innovation and learning (Storper and Scott, 2009). The effect of this is that the spatial inequality of human capital persists over time, as educated individuals are constantly being attracted to these agglomerations to further encourage the positive feedback process.

Thus, a variety of factors and migratory behaviours lead to significant spatial variations in human capital. Whilst the process through which human capital migrates to seek high returns and the effects this has on economic growth is interesting in itself, the focus here is on how spatial concentrations of human capital, as a result of these processes, impacts regional firm birth rates. This somewhat bypasses the issues that Storper and Scott (2009) suggest can beset cross sectional analyses within this research context, namely the presence of diachronic and multi-direction causalities. Past empirical research has sought to analyse the relationship between the concentrations of educated individuals and entrepreneurship, typically with positive results. For example, Audretsch and Keilbach (2004a) found that regions with a higher level of human capital, measured through the percentage of the local labour force with a Master's degree, typically exhibit higher firm births rates; moreover, this estimate is robust across entrepreneurship in high tech and ICT industries, as well as general entrepreneurship across all industries. Similarly, Evans and Leighton (1989) find that the probability of entering into entrepreneurship significantly increases with the attainment of college/university degrees and then further with the attainment of post graduate degrees. This also highlights that different levels of education can have different causal effects on the tendency to partake in entrepreneurship, through endowing individuals with different levels of entrepreneurial ability.

The effects of concentrations of human capital are not just restricted to entrepreneurship, but may also influence other economic phenomena. Shapiro (2006) shows that human capital growth is associated with employment growth, suggesting that "a highly educated local population generates greater local productivity, perhaps through [the existence of] knowledge spillovers or pecuniary externalities arising from job search". Interestingly, the type of education appears to be relevant, as a causal effect is found between employment growth and concentrations of college (university) graduates, but a higher concentration of high school graduates does not exhibit the same effect. Similarly, Andersson, Quigley and Wilhelmsson (2005) show, using Swedish data, a link between human capital and innovative activity, namely that patent issues are greater in regions with a higher concentration of more educated individuals. Given these results and the theoretical propositions established earlier relating to the influence of tacit knowledge and human capital on the entrepreneurial process, higher spatial concentrations of educated individuals are expected to have a positive effect on sub-regional firm birth rates.

In light of this research, three different explanatory variables will be utilised to measure the regional residential concentrations of educated individuals. The first measures the proportion of the regional population who hold a university degree (DEGREE) and is frequently used in empirical literature looking to approximate local human capital (Andersson, Quigley and Wilhelmsson, 2005; Audretsch and Keilbach, 2004a; Shapiro, 2006). The second measures the proportion of the regional population who hold at least an NVQ level 1 qualification and above (NVQ1PLUS) as an approximate measure of a basic level of education. The third variable measures the proportion of the regional population who do not hold any recognisable qualification (NOQUAL), as an approximation of the lack of human capital in a region. Quartile maps showing the spatial distribution of these variables can be found in the Appendix (A17, A18, and A19 respectively).

The spatial distribution of university graduates (Appendix: A17) shows London and the South East appear to have a higher concentration of human capital relative to the rest of GB. The quartile map showing the spatial distribution of the NVQ1PLUS variable (Appendix: A18) shows a similar pattern, in that the south of England might be said to have a higher concentration of individuals with at least some form of basic education qualification; however, this spatial pattern is altogether weaker. An interesting spatial pattern can be observed in the NOQUAL variable (Appendix: A19). In some sense, this might be considered as the reverse of the NVQ1PLUS variable. This is seen to some extent, particularly across the south of England where a relatively low proportion of the population across this area appear to lack education qualifications. However, what is particularly noticeable in the NOQUAL variable is that a number of urban areas appear to be home to a high concentration of people who lack formal education qualifications, as indicated by the darker shaded regions of the quartile map (Appendix: A19). This is reaffirmed by the LISA cluster map of the NOQUAL variable (Appendix: A20). The conurbations of Birmingham, Liverpool, Manchester and their surrounding areas, as well as East London, appear to represent significant clusters of LAD's where the prevalence of people with no qualifications is quite high. Specifically, the LAD's of Birmingham, Walsall, Wolverhampton, Stoke-on-Trent, Leicester, Liverpool, Blackburn and Darwen, Knowsley, Glasgow City, Barking and Dagenham, and Waltham Forrest, comprising parts of major urban areas, all have at least 19% of their populations without any recognisable education qualifications. Interestingly, some of the clusters of regions that exhibit high concentrations of people lacking formal education qualifications lie within OIRs in the north-east and north-west of England, the south-west of Scotland and south Wales. Within the context of this chapter, this might suggest that one reason why OIRs might exhibit lower firm birth rates is that they lack the requisite human capital necessary to recognise potential entrepreneurial opportunities; this will be exposed in the regression analysis to come that controls for the effect of both human capital and OIRs concurrently. Finally, the LISA cluster map (Appendix: A20) shows that the South of England and parts of the South West contains a particularly large and significant cluster of LAD's where the population has at least some form of formal qualification.

It is difficult to put cross-sectional analyses of spatial variations in human capital into context without looking at how they evolve over time and with respect to other variables. However, the spatial distribution of the DEGREE variable is in keeping with Faggian and McCann (2006), who suggest that the migration of human capital tends towards regions of higher wages; the previous chapter showed that the London and South East exhibited higher nominal wages in comparison to the rest of the country. In addition to the tendency of human capital migration towards regions with higher nominal wages, the cross section dynamics of the spatial distribution of human capital are influenced by the two other factors. The first is that the returns to human capital vary across space, in that "nominal wage differential between British regions are partly explained by the non-homogeneity of the regional labour force" (Faggian and McCann, 2009). Second, and specifically in reference to GB regions, the attraction of London and the South East to university graduates is quite apparent in their migration patterns:

> "There appears to be something of a centre-periphery phenomenon in terms of the spatial pattern of the graduate employment opportunities generated... The spatial variations and constraints in the generation of such job opportunities in turn appear to be related to the rank-order of the area within the national urban hierarchy, centred on London and its hinterland regions" (Faggian and McCann 2009: 321)

All of these forces result in a 'life-cycle effect according to a regional escalator process', such that employment and migration patterns in GB show that "young persons and university graduates are attracted to London and the South East from other regions in order to enter employment and training" (Faggian and McCann, 2009:321). Whilst the cross-sectional nature of this research can't illustrate this temporal process, the spatial distribution of human capital , as suggested by the DEGREE variable, reflects the results of this process, as London and the South East generally contain regions with the highest concentration of graduates. There is also some precedence in the literature that considers the lack of human capital in some urban areas. For example, the prevalence of sub-regions with low concentrations of human capital located in and around major British urban centres is perhaps an indication of social exclusion. Percy-Smith (2000) highlights the 'lack of opportunity for education' as one of the key features of social exclusion, and that social exclusion 'particularly affects individuals and groups in urban areas' (Percy-Smith, 2000:3). The spatial distribution of the NOQUAL variable is a reflection of the prevalence of social exclusion in urban areas

Overall, the data show a fairly uneven distribution of human capital across GB from 2008-2010. London and the South East appear to have higher concentrations of university graduates (DEGREE), whereas the South and South West appear to have higher concentrations of individuals with at least some form of basic qualification (NVQ1PLUS). There is tentative evidence that a North-South divide exists in the distribution of human capital, not particularly because the North has generally low concentrations of human capital, but the fact that higher concentrations of human capital are generally located in the south of England. Cross sectional analyses of this nature do not particularly shed light on whether this uneven distribution is as a result of uneven economic activity, or whether it is the cause of such; however, the regression analysis will shed light of whether the uneven spatial distribution of human capital can be expected to explain a significant degree of the observed uneven spatial distribution of entrepreneurial activity. It is expected that DEGREE and NVQ1PLUS will have a positive effect on regional firm birth rates, whereas NOQUAL is anticipated to have a negative effect.

8.3.2 – Experience

Schultz (1975; 1980) emphasises that experience is a key determinant of entrepreneurial ability, whereas Shane (2000) suggests that 'prior' knowledge gained through one's past activity, determines the way in which an entrepreneur might appropriate a particular opportunity. Unfortunately, these concepts are most relevant at the level of the individual, as the concept possibly loses some of its meaning when translated upwards to the aggregated perspective of a regional population. However, the fundamental aspect of experience is that it must depend on the past, and whilst it might simplify the issue somewhat to suggest that older people embody a greater level of experience, a person's experience is likely to depend on their age.

The basic premise is that as a person ages, they gain greater experience in the labour market that provides them with a greater level of entrepreneurial ability. This in isolation would suggest a positive linear relationship between age and entrepreneurial tendency. However, some research (Bönte, Falck and Heblich, 2009; Wennekers*, et al.*, 2005) has hypothesised the existence of an 'inverse U' shaped relationship between the probability of starting a firm and a person's age. Two forces are at work, the requisite experience needed to behave entrepreneurially that is generally considered to increase with age, and the willingness to behave entrepreneurially that is generally considered to decrease with age. Younger people are theorised to have a high willingness to behave entrepreneurially, but lack the requisite experience in order to know how to do so; conversely, older people are said to have the experience necessary to successfully behave entrepreneurially, but lack the willingness to do so. This results in the 'prime' age for starting a business to be 'about 40' (Bönte, Falck and Heblich, 2009).

Based on these insights it can be suggested that age structure of a regional population may have a significant effect on the regional firm birth rate. This perspective is considered in both Shane (1996) and Acs*, et al.* (2009), who specify the prevalence of people within a population belonging within specified age cohorts as an explanatory variable determining entrepreneurship. These two studies use completely different methodological approaches. Shane (1996) utilises a range of time series models to explore the determinants of entrepreneurship from a temporal perspective, whereas Acs*, et al.* (2009) utilise cross-sectional data to analyse cross-national variations in entrepreneurship; the latter is more closely related to the current research. Both of these studies find different results. Shane (1996) finds some evidence that an increasing presence of people aged 25-34 can have a significant effect on entrepreneurial activity, but the estimates are sensitive to the inclusion of other explanatory variables. Furthermore, there is no evidence that this extends to people aged 35-44. Acs*, et al.* (2009) find that an increasing presence of people aged 30-44 within a population has a significantly positive effect on entrepreneurial activity.

A similar methodological approach to both Shane (1996) and Acs, *et al.* (2009) will be utilised here. Using data collected from the Annual Population Survey, the percentage of the regional population aged 16+ aged from 25-34 (PERC2534), 35-49 (PERC3549), and 50-64 (PERC5064) will be used as explanatory variables. One issue in comparing results across these studies is the variation seen in size of the age cohorts used; unfortunately, the availability of data restricted the computation of age cohorts of equal size or of equal ranges to those used in Shane (1996) or Acs, *et al.* (2009). The selection of these age ranges is not to say that people aged 65 and above and people aged 16-24 are unimportant when it comes to entrepreneurship; rather, they were deemed the least suitable age cohorts to focus on due to data restrictions and the need for a base age group with which to compare to the estimated coefficients. Based on the insights regarding age and entrepreneurship presented here, both of these excluded age cohorts would be expected to exhibit lower entrepreneurial tendency but for different reasons; people aged 16-24 might lack the experience necessary to behave entrepreneurially, whilst those over 65, i.e. retirees, may lack the willingness to do so. Accordingly, the 25-34, 35-49, and 50-64 age cohorts might all exhibit positive coefficients in comparison. However, if experience is to have a significantly positive effect on firm birth rates and the inverse U shaped relationship is to hold, it is expected that the 35-49 age group will have the largest marginal effect on firm birth rates. This age group is most likely to hold individuals who strike the optimal balance between the required experience for and the willingness to undertake entrepreneurship.

Quartile maps showing the spatial distribution of the PERC2534, PERC3549, and PERC5064 variables are in the Appendix (A21, A22, and A23 respectively) and it can be observed that there exists a significant spatial variation in the distribution of people within these age cohorts. First, the quartile map for PERC2534 (Appendix: A21) shows that London has a high proportion of younger individuals in comparison to the rest of the country, as indicated by the dark shaded regions of the map. Of the next age group, 35-49 (Appendix: A22), regions that have a larger proportion of individuals in the age range seem to be predominantly located in the area surrounding London, the South East, and towards the Midlands. The oldest age cohort, 50-64, appears to be generally located in the peripheral regions of GB (Appendix: A23), namely Scotland, Wales, and northern England and the South West. These patterns can be seen even more clearly through the use of LISA cluster maps (Appendix: A24). The map on the left of the figure (PERC2534) shows that London is a statistically significant cluster of regions with a high concentration of people aged 25-34, whereas the map on the right of the figure (PERC5064) shows that these same regions comprise a cluster of regions with low concentrations of people aged 50-64. The central map of this figure (PERC3549) suggests that the regions surrounding London comprise a significant cluster of regions with a high concentration of people aged 35-49.

The spatial distribution appears to be rather stable over time, as the cluster maps of these variables using census data from 1991 and 2001 show very similar patterns (Appendix: A25, A26, and A27 for PERC2534, 3549, and 5064 respectively). The stability of this pattern might suggest that younger professionals are attracted to working and living in London, moving outwards from London as they progress through their careers and taking their experience with them. In this sense, London could be considered a training ground for younger workers, providing a vibrant environment in which to further their careers and learn relevant skills. Relative to other major cities in GB, London benefits from significantly greater network externalities, due to its international connectedness and presence of major multi-national corporations, as well as labour market externalities relating to reduced search costs for employment and knowledge and learning spillovers. Additionally, younger people may be attracted to the abundance of local 'amenities' available in urban centres such as London, in keeping with the theories of Glaeser (2005), and the cities as an 'entertainment machine' (Clark*, et al.*, 2002), both of which are described by Storper and

Scott (2009). It is plausible that young individuals seeking to further their careers view London in this way and benefit professionally by locating there.

This descriptive analysis shows that the age structure of regional populations can vary significantly over space. Given that age has been shown to be a significant determinant of a person's propensity for entrepreneurship (Bönte, Falck and Heblich, 2009; Shane, 1996; Wennekers*, et al.*, 2005), this may have consequences in terms of regional entrepreneurship. It is expected that the PERC3549 variable will have the largest positive marginal effect on firm birth rates, whereas the effect of the other two age cohorts remains to be seen.

8.3.3 – Ethnic Diversity

Finally, as a point of interest and due to precedence in the literature (Audretsch, Dohse and Niebuhr, 2010; Bishop, 2012), the ethnic diversity of regional populations will also be assessed for its effect on regional entrepreneurship. Smallbone, Kitching and Athayde (2010) discuss the extent to which ethnic diversity can be a source of competitiveness at a city or regional level. They explicitly link ethnic diversity to entrepreneurship by highlighting that "self-employment and business ownership rates are often higher among some ethnic minorities than among the indigenous white population" (Smallbone, Kitching and Athayde, 2010). Furthermore, immigrant based business ownership is said to constitute a growing international trend, evident in Britain, the Netherlands, Germany, and Australia. Ethnic diversity is also suggested to contribute significantly to creativity and innovation, where individuals draw on cultural traditions and experiences as an input to the creative process to create something new and distinctive. Empirically this is supported by the influence of ethnic diversity on London's creative industries, a particularly high value added sector that contributes to other parts of London's economy through 'secondary impacts and interdependencies' (Smallbone, Kitching and Athayde, 2010). This is quite closely linked to the work of Florida (2002; 2004, cited in Storper and Scott, 2009), who relates the presence of a 'creative class' to greater local creativity; this creative class is attracted to the supposed 'tolerance' that characterises ethnically diverse areas. These diverse areas are more accepting of innovation, change, and creativity, which act as a conduit for entrepreneurial activity. These theories could easily be extended to the context of tacit knowledge that is the focus of this chapter. Individuals of different ethnic backgrounds and cultures, with their socially unique institutions, social systems, and norms, could arguably perceive and assess entrepreneurial opportunities differently from others. Specifically, the ability to recognise and exploit certain opportunities may stem from receiving the cultural experience necessary to provide nascent entrepreneurs with the specific cognitive attributes and attitudes. The main premise here is that some entrepreneurial opportunities require certain cultural experiences to provide the ability to recognise and appropriate them, and a more ethnically diverse population increases the likelihood of those skills being present.

In order to measure ethnic diversity, data from the Annual Population Survey was used. This survey asks respondents to classify their ethnicity in one of the following six categories: White, Black, Indian, Pakistani/Bangladeshi, Mixed, or Other; a simple HII index was calculated for each region based on the relative proportions in each category. As it is specifically hypothesised that diversity has a positive impact on firm start-up rates, the inverse of the HHI was taken (ETHDIV). Thus, positive coefficients in the regression results indicate that an increase in the ethnic diversity across a sub-regional population has a positive impact on firm birth rates. The quartile map of ETHDIV (Appendix: A28) shows that it is mainly urban areas that have more ethnically diverse populations. Unsurprisingly, the LAD's located in Greater London are shown to be the most ethnically diverse, with Birmingham, Manchester, Leicester, and Luton also ranking highly in terms of the ethnic diversity of their populations. These observations are in accordance with Smallbone, Kitching, *et al.* (2010), who recognise London as the most "ethnically diverse city in the UK and one of the most ethnically diverse in the world." Overall, London serves as GB's most ethnically diverse location by some distance and generally, the rest of the sub-regions of GB are rather uniform in their ethnicity

8.3.4 – Control Variables

The control variables are based on those described and used in the previous chapter and include: a general measure to approximate the presence of agglomeration externalities (EMPDENS); ‘barriers to entrepreneurship’ measured by proxy using regional employment in Public Administration Activities and Defence, covered by Section 84 of 2007 SIC codes (PSEMP); structural factors relating to unemployment, measured using the regional claimant rate (CLAIMRATE); and a measure of the financial constraints faced by regional populations, approximated by using regional median incomes (INCOME). Two additional indicator variables will also be used; the first indicates whether a region can be classified as an OIR (Birch, MacKinnon and Cumbers, 2010) to approximate any negative effects that this might have on regional entrepreneurship, coded 1 if a region is consider an OIR and 0 otherwise; the second indicates the City of London, coded 1 for the City of London and 0 otherwise, due to its extremity as an outlier as far as the dependent variable is concerned, which is again a log-transform of firm births per 1000 of the working population (LNFB1000). The data sources for all of the explanatory variables used in this chapter can be found in the Appendix (A29).

8.4 – Descriptive Statistics

Table 8.1. Descriptive statistics of explanatory variables

	μ	σ	CV	Min	Max
DEGREE	20.48	8.77	0.43	5.37	81.35
NVQ1PLUS	80.15	5.33	0.07	55.37	91.73
NOQUAL	11.89	3.91	0.33	4.20	24.37
PERC2534	14.68	4.83	0.33	6.57	47.90
PERC3549	27.03	2.95	0.11	14.83	37.30
PERC5064	23.59	3.41	0.14	12.43	33.17
ETHDIV	1.37	0.65	0.48	1.02	5.99

Table 8.2. Correlation matrix of explanatory variables. Correlation coefficients are calculated using Pearson's product-moment correlation method (*r*).

	1	2	3	4	5	6	7	9	9	10	11
1	X										
2	0.342	X									
3	-0.527	-0.800	X								
4	0.501	-0.358	0.097	X							
5	0.292	0.055	-0.168	0.240	X						
6	-0.337	0.330	-0.064	-0.783	-0.411	X					
7	0.398	-0.533	0.075	0.683	0.223	-0.620	X				
8	0.457	0.026	0.000	0.505	0.131	-0.234	0.187	X			
9	-0.086	-0.102	0.132	0.011	-0.122	-0.057	0.008	-0.045	X		
10	-0.360	-0.687	0.719	0.318	-0.091	-0.318	0.260	-0.001	0.202	X	
11	0.727	0.275	-0.445	0.360	0.451	-0.265	0.353	0.288	-0.204	-0.362	X

1: DEGREE 2:NVQ1PLUS; 3: NOQUAL; 4: PERC2534; 5: PERC3549; 6: PERC5064; 7:ETHDIV; 8: EMPDENS; 9: PSEMP; 10: CLAIMRATE; 11: INCOME

Table 8.1 shows the descriptive statistics of the explanatory variables and Table 8.2 displays the correlation matrix showing the Pearson's correlation coefficients (*r*) for each of these explanatory variables. The μ of the DEGREE variable shows that, on average from 2008-2010, approximately 20% of the population of working age held a university degree. There seems to be a fair amount of variation in the concentrations of university graduates between regions, as only 5% of the working population are university graduates in some regions. However, the CV and range of the DEGREE variable is exacerbated by the City of London LAD and its unusually small resident population of working age that makes it an extreme outlier. The μ of the NOQUAL variable shows that, on average from 2008-2010, approximately 11% of the GB population lacked any recognisable education qualifications. What is most noticeable about the NOQUAL variable is the variation between the LADs of GB; some regions are observed to have as a high as 24% of the resident population of working age lacking such qualifications, whereas as this figure drops to 4% in other regions.

In terms of the correlation coefficients of Table 8.2, there are two strong correlations that might cause particular problems: the strong positive correlation observed between the DEGREE and INCOME variables (0.727), as well as the strong negative correlation observed between the NOQUAL and CLAIMRATE variables (0.719). That regions with a higher concentration of university graduates have higher incomes reflects that human capital flows towards regions with higher nominal incomes (Faggian and McCann, 2006). Furthermore, that regions with a higher proportion of unqualified people also tend to exhibit a higher claimant rate is also somewhat expected, as a lack of education qualifications might be a cause of structural unemployment. Finally, there also appears to be a fairly strong positive correlation between the ETHDIV variable and the PERC2534 variable; this reflects the fact that urban areas are typically more ethnically diverse and also typically attract younger people. As a precautionary measure, some of the explanatory variables will be excluded from the computation of some models in order to assess the sensitivity of the estimated coefficients of some of the other variables.

8.5 – OLS Linear Regression Results

Table 8.3. OLS linear regression results. Dependent variable: LNFB1000. No. of observations = 408.

	M1	M2	M3	M4	M5
Constant	0.955 (0.00)***	0.837 (0.003)***	0.929 (0.00)***	0.927 (0.00)***	1.089 (0.00)***
% of regional population who hold a degree (DEGREE)	0.0046 (0.024)**			0.0057 (0.011)**	0.012 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0011 (0.668)			
% of regional population who have no educational qualifications (NOQUAL)			0.0009 (0.778)	0.0052 (0.146)	0.0053 (0.171)
% of regional population 16+ aged 25-34 (PERC2534)	-0.0083 (0.034)**	-0.0056 (0.162)	-0.0057 (0.156)	-0.0088 (0.024)**	-0.0068 (0.106)
% of regional population 16+ aged 35-49 (PERC3549)	0.0026 (0.446)	0.002 (0.558)	0.0019 (0.573)	0.0026 (0.435)	0.013 (0.00)***
% of regional population 16+ aged 50-64 (PERC5064)	0.0061 (0.148)	0.0063 (0.136)	0.0060 (0.162)	0.0054 (0.209)	0.011 (0.020)**
Ethnic Diversity Index (ETHDIV)	0.128 (0.00)***	0.139 (0.00)***	0.133 (0.00)***	0.124 (0.00)***	0.138 (0.00)***
Employment Density (EMPDENS)	0.00004 (0.00)***	0.00004 (0.00)***	0.00004 (0.00)***	0.00003 (0.00)***	0.00004 (0.00)***
Public Sector Employment (PSEMP)	-1.485 (0.00)***	-1.413 (0.00)***	-1.395 (0.00)***	-1.471 (0.00)***	-1.782 (0.001)***
Claimant Rate (CLAIMRATE)	-0.069 (0.00)***	-0.080 (0.00)***	-0.085 (0.00)***	-0.078 (0.00)***	-0.093 (0.00)***
Median Incomes (INCOME)	0.0014 (0.00)***	0.0016 (0.00)***	0.0017 (0.00)***	0.0014 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.112 (0.00)***	-0.107 (0.00)***	-0.108 (0.00)***	-0.116 (0.00)***	-0.129 (0.00)***
City of London Dummy (LONDUM)	-1.209 (0.00)***	-1.317 (0.00)***	-1.339 (0.00)***	-1.233 (0.00)***	-2.166 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using HAC standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
R^2	0.801	0.797	0.797	0.802	0.769
F Statistic	144.824	141.297	141.257	133.408	119.689
Log Likelihood	177.010	172.992	172.945	178.228	146.478
AIC	-330.020	-321.984	-321.890	-330.449	-268.956
Breusch Pagan Test	30.571 (0.001)***	18.276 (0.075)*	22.728 (0.019)**	32.748 (0.001)***	63.155 (0.00)***

Table 8.3 shows the linear regression results for models M1-M5 using an OLS estimation procedure, with each model using different combinations of explanatory variables. M1-M3 tests each of the education variables DEGREE, NVQ1PLUS, and NOQUAL individually, whereas M4 assesses the effects of the DEGREE and NOQUAL variables

together. Excluding the INCOME variable in M5 has a large effect on the magnitude and significance of the DEGREE, PERC3549, and PERC5064 variables. The DEGREE variable, whilst still significant at a 95% confidence level in M1 and M4, doubles in magnitude and becomes significantly different from 0 at a 99% confidence level when INCOME is excluded. Similarly, the estimated coefficients of the PERC3549 and PERC5064 variables do not show any significance in models M1-M4 but exhibit a large increase in magnitude and are estimated to be significantly different from 0 in M5 with the exclusion of the INCOME variable. Given the nature of the data, it is reasonable to suggest that the estimates of the DEGREE, PERC3549, and PERC5064 variables in M5 suffer from an omitted variable bias from the exclusion of the INCOME variable. The reason for this is that individuals with degrees, those aged 35-49 and aged 50-64 are likely to have a higher level of income relative to others, such that their estimated coefficients in M5 are upwardly biased due to the indirect effect of incomes needing to be controlled for. Thus, the estimates of these variables in M5 do not truly represent the effect of having a degree or labour market experience on entrepreneurial activity. Fortunately, the DEGREE variable is statistically significant even when incomes are controlled for, however the statistical significance of the PERC3549 and PERC5064 variables in M5 should be interpreted with caution. Excluding the CLAIMRATE and ETHDIV variable to assess the sensitivity of the coefficients of the NOQUAL and PERC2534 variables, respectively, makes little difference to the results. Estimating M3 without the CLAIMRATE variable makes the estimated coefficient of NOQUAL highly statistically significant, but makes no difference to the significance of the estimates in M4 or M5. Similarly, excluding the ETHDDIV variable from the analysis also makes little difference to the estimated coefficients of the PERC2534 variable; doing so makes the estimate insignificant in M1 and leaves the estimates in M2-M5 unaltered in any significant way. As these models do not alter the results in any significant degree, they have not been presented for brevity.

In terms of the explanatory power of the models, models M1-M5 have a similar level of explanatory power to the OLS models of the previous chapter, in that models M1-M4 explain approximately 79%-80% of the variation in the dependent variable (LNFB1000).

Similar figures are observed for the AIC across models M1-M4. The AIC statistic of M5 suggests that a fairly large drop in explanatory power when the INCOME variable is excluded from the analysis, as can be seen by its comparison with the AIC of M4 when the INCOME variable is included; accordingly, models M1-M4 are probably preferable. Similar to the models of the previous chapter, the residuals of all of the OLS models M1-M5 exhibited a significant degree of heteroskedasticity, evidenced by the statistically significant Breusch Pagan statistics. Accordingly, the standard errors used to compute the p-values of the estimated coefficients were adjusted for heteroskedasticity using HAC standard errors.

The estimated coefficients of the DEGREE, NVQ1PLUS, and NOQUAL variables show a varied set of results regarding the impact of human capital and entrepreneurial ability on entrepreneurial activity. First, and perhaps most importantly, the estimated coefficient of the DEGREE variable is both positive and highly significant across all of the relevant OLS models, being considered significantly different from 0 at a 95% confidence level in M1 and M4 when the INCOME variable is also included, and at a 99% confidence level in M5. The size of this estimated marginal effect is sensitive to the other variables in the models, particularly the INCOME variable, but the estimate of M1 suggests that a 1% increase in the proportion of the regional population of working age who are university graduates should be expected to correspond with a 0.46% increase in the firm birth rate, *ceteris paribus*; this estimate increases to an expected 0.57% increase in the regional firm birth rate when tested with the NOQUAL variable in M4. The estimates of M5 suggest that a 1% increase in the proportion of the regional population of working age who are university graduates can be expect to correspond with an approximate 1.2% increase in the regional firm birth rate, *ceteris paribus*; however, a proportion of this estimated marginal effect in this model can be attributed to the excluded INCOME variable. Thus, there is consistent and robust evidence that an increase in the concentration of university graduates within a region leads to an increase in regional entrepreneurial activity. These findings are in line with both Audretsch and Keilbach (2004a) and Evans and Leighton (1989).

There is no evidence that the attainment of basic education, when measured with the NVQ1PLUS variable, is particularly conducive to regional entrepreneurial activity as the estimated coefficient of the NVQ1PLUS variable in M2 is insignificant. Furthermore, there is no evidence that the lack of attainment of such education qualifications has any effect on the regional firm birth rate; again, the estimated coefficients of the NOQUAL variable are insignificant across all of the relevant models, whether tested independently (M3) or with the DEGREE variable (M4 and M5). Interestingly, the AIC suggests that the 'information' content of M4 is greater in comparison with M1, suggesting that the inclusion of the DEGREE and NOQUAL variables together increases the models overall explanatory power.

The OLS models provide limited evidence that the experience of a regional population enhances entrepreneurial ability in a way that encourages regional entrepreneurship. The age cohort variables are tested together throughout M1-M5, as testing them independently makes a negligible difference to the interpretative significance of the results. First, the coefficient of the PERC2534 variable is negative and estimated to be significantly different from 0 at a 95% confidence level in both M1 and M4, suggesting that a younger regional population can be expected to be less entrepreneurial. This result might suggest that people in this age cohort lack the experience necessary to successfully identify and exploit entrepreneurial opportunities; however the estimate is sensitive to the other explanatory variables included within the models, which detracts from the robustness of this result.

There is no evidence across models M1-M4 that an increasing presence of people aged 35-49 or 50-64 within a regional population has any effect on regional firm births. However, as highlighted earlier, the estimates of M5 show a significant interaction between the INCOME variable and age cohort variables; the estimates from this model provide evidence that experience encourages entrepreneurship through the enhancement of entrepreneurial ability. Both the PERC3549 and PERC5064 variables exhibit positive coefficients that are estimated to be significantly different from 0 at a 99% confidence level. This implies that older regional populations are generally more entrepreneurial, and that age structure has a significant effect on the regional firm birth rate. Moreover, there appears to be some evidence for the 'inverse U' shaped relationship between age and the probability of staring a firm, where there is a peak age of 'about 40' (Bönte, Falck and Heblich, 2009; Wennekers*, et al.*, 2005). This is evidenced by the estimated coefficient of the PERC3549 variable being larger than the estimated coefficient of the PERC5064 variable, suggesting an increase in the percentage of people aged 35-49 within a regional population has a greater marginal effect on the regional firm birth rate than an identical increase in the percentage of people aged 50-64. However, that these estimates are particularly sensitive to the inclusion of the INCOME variable significantly detracts from the strength of these conclusions. That the PERC3549 and PERC5064 variables are insignificant when INCOME is included may highlight that older people generally receive higher incomes and that it can take time to accumulate adequate start-up capital (Evans and Jovanovic, 1989), effects needing to be controlled for. As such, it should be remembered that the estimated coefficients of the age variables from M5 should be interpreted with caution.

Finally, there is consistent and robust evidence that an ethnically diverse population is typically more entrepreneurial, as the estimated coefficient of the ETHDIV variable is both positive and significantly different from 0 at a 99% confidence level across all of the OLS models presented here. These empirical results reaffirm the results of Audretsch, Dohse and Niebuhr (2010) and Smallbone, Kitching and Athayde (2010), as well as the theoretical position of Florida (2002; 2004, cited in Storper and Scott, 2009) relating the presence of the creative class typically associating itself with ethnically diverse areas. This could possibly be attributed to the fact that certain entrepreneurial opportunities might only be recognised and adequately assessed by those of a certain ethnic persuasion, as they are endowed with the culturally relevant 'tacit' knowledge. However, it should be noted that Bishop (2012) failed to find any significant relationship between ethnic diversity and entrepreneurship, using a similar diversity measure. The one crucial difference between Bishop's (2012) findings and the results presented here is the nature of the dependent variable, as the firm birth variable is used here is more comprehensive than the VAT registrations used by Bishop (2012); this might go some way to explaining the difference in the regression estimates.

As far as the control variables are concerned, the main difference between the estimated coefficients observed here and the estimated coefficients in the models of the previous chapter regards both the magnitude and significance of the estimated coefficient of the PSEMP variable. Models M1-M5 suggest that the estimated negative marginal effect of additional employment in public administration activities is much larger than those in the OLS models of the previous chapter. Furthermore, the estimates presented here are all significantly different from 0 at a 99% confidence level. This provides further evidence of the detrimental effect that local 'barriers to entrepreneurship' has on local firm births, reaffirming the *Barriers to Entrepreneurship Hypothesis* (Acs*, et al.*, 2009). However, this does highlight the sensitivity of the estimated coefficients of the PSEMP variable to the inclusion of other explanatory variables, detracting from the robustness of this interpretation. The interpretation of the coefficients of the EMPDENS, CLAIMRATE, INCOME, OIR, AND LONDUM variables remain the same as in the previous chapter, retaining their level of significance and adding to the inductive strength of the relevant interpretations.

Having estimated models M1-M5 using an OLS linear regression estimation procedure, the models were estimated using appropriate spatial specifications, first using contiguity based spatial weights (QCO1 and QCO2), followed by nearest neighbours based spatial weights (4NN and 8NN). Generally, the LM spatial diagnostic tests (Appendix: A30) suggest that when using spatial weights matrices that designate areas of neighbouring regions that are smaller (QCO1 and 4NN), a spatial lag specification is advised; however, when using spatial weights matrices that designate larger neighbouring areas (QCO2 and 8NN), a spatial error specification is advised. The differences between the spatial diagnostics of these models, in comparison with the spatial diagnostics of the previous chapter, perhaps shows the different spatial dynamics of the different forms of tacit and explicit knowledge; specifically, that human capital and embodied knowledge behaves differently over space in comparison to the explicit knowledge produced by the research activities of knowledge intensive industries. As the significance of the spatial diagnostics tests are very similar, spatial lag and spatial error specifications were computed for each OLS model M1-M5 using each spatial weights matrix to test for any significant differences in the results. However, doing so made little interpretive difference, such that only the spatial lag models of M1-M5 using QCO1 and 4NN spatial weights and the spatial error models using QCO2 and 8NN spatial weights are presented in the interests of avoiding excessive output. The following Sections 8.6 and 8.7 summarise the results of these models.

8.6 – ML Spatial Regression Models with Contiguous Spatial Weights

Table 8.4. Spatial lag models of M1-M5 using QC01 spatial weight matrix. Dependent variable: LNFB1000. No. of observations = 408.

	SM1	SM2	SM3	SM4	SM5
Constant	0.705 (0.00)***	0.651 (0.022)**	0.672 (0.00)***	0.665 (0.00)***	0.733 (0.00)***
% of regional population who hold a degree (DEGREE)	0.0048 (0.002)***			0.0061 (0.00)***	0.011 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0004 (0.873)			
% of regional population who have no educational qualifications (NOQUAL)			0.0019 (0.505)	0.0065 (0.036)**	0.007 (0.035)**
% of regional population 16+ aged 25-34 (PERC2534)	-0.010 (0.004)***	-0.0074 (0.033)**	-0.0074 (0.033)**	-0.011 (0.002)***	-0.010 (0.019)***
% of regional population 16+ aged 35-49 (PERC3549)	0.0022 (0.478)	0.0016 (0.608)	0.0016 (0.621)	0.0023 (0.465)	0.0104 (0.00)***
% of regional population 16+ aged 50-64 (PERC5064)	0.0075 (0.066)*	0.0076 (0.069)*	0.0072 (0.083)*	0.0066 (0.106)	0.011 (0.011)**
Ethnic Diversity Index (ETHDIV)	0.107 (0.00)***	0.115 (0.00)***	0.112 (0.00)***	0.102 (0.00)***	0.108 (0.00)***
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-0.917 (0.00)***	-0.840 (0.003)***	-0.820 (0.003)***	-0.888 (0.001)***	-1.002 (0.00)***
Claimant Rate (CLAIMRATE)	-0.064 (0.00)***	-0.076 (0.00)***	-0.082 (0.00)***	-0.075 (0.00)***	-0.086 (0.00)***
Median Incomes (INCOME)	0.0012 (0.00)***	0.0014 (0.00)***	0.0014 (0.00)***	0.0011 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.090 (0.00)***	-0.086 (0.00)***	-0.087 (0.00)***	-0.096 (0.00)***	-0.101 (0.00)***
City of London Dummy (LONDUM)	-0.506 (0.381)	-0.631 (0.278)	-0.652 (0.263)	-0.524 (0.361)	-1.084 (0.070)*
W_LAG LNFB1000	0.208 (0.00)***	0.207 (0.00)***	0.208 (0.00)***	0.212 (0.00)***	0.257 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.824	0.820	0.820	0.826	0.807
Log Likelihood	200.672	195.787	195.996	202.857	180.550
AIC	-375.344	-365.574	-365.992	-377.714	-333.100
Breusch Pagan Test	30.753 (0.001)***	11.182 (0.428)	15.642 (0.155)	33.403 (0.00)***	58.116 (0.00)***
Wald Test	49.971	47.997	48.497	52.287	73.222
Likelihood Ratio Test	47.324 (0.00)***	45.590 (0.00)***	46.102 (0.00)***	49.265 (0.00)***	67.525 (0.00)***
LM Test	46.090	44.490	45.015	47.905	64.363

Table 8.5. Spatial error models of M1-M5 using QCO2 spatial weight matrix. Dependent variable: LNFB1000. No. of observations = 408.

	SM6	SM7	SM8	SM9	SM10
Constant	1.041 (0.00)***	0.861 (0.003)***	1.006 (0.00)***	1.000 (0.00)***	1.394 (0.006)***
% of regional population who hold a degree (DEGREE)	0.0064 (0.00)***			0.0073 (0.00)***	0.013 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0017 (0.520)			
% of regional population who have no educational qualifications (NOQUAL)			-0.0004 (0.906)	0.0045 (0.157)	0.0036 (0.279)
% of regional population 16+ aged 25-34 (PERC2534)	-0.0084 (0.015)**	-0.0049 (0.151)	-0.005 (0.145)	-0.0088 (0.011)**	-0.010 (0.004)***
% of regional population 16+ aged 35-49 (PERC3549)	0.0002 (0.948)	-0.0006 (0.857)	0.0006 (0.854)	0.0005 (0.884)	0.0039 (0.218)
% of regional population 16+ aged 50-64 (PERC5064)	0.0065 (0.101)	0.0062 (0.133)	0.0059 (0.148)	0.0061 (0.128)	0.0084 (0.039)**
Ethnic Diversity Index (ETHDIV)	0.101 (0.00)***	0.119 (0.00)***	0.111 (0.00)***	0.098 (0.00)***	0.076 (0.00)**
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-1.163 (0.00)***	-1.133 (0.00)***	-1.124 (0.00)***	-1.160 (0.00)***	-1.157 (0.00)***
Claimant Rate (CLAIMRATE)	-0.068 (0.00)***	-0.082 (0.00)***	-0.085 (0.00)***	-0.075 (0.00)***	-0.080 (0.00)***
Median Incomes (INCOME)	0.0013 (0.00)***	0.0016 (0.00)***	0.0017 (0.00)***	0.0013 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.071 (0.002)***	-0.075 (0.001)***	-0.076 (0.00)***	-0.075 (0.001)***	-0.053 (0.038)**
City of London Dummy (LONDUM)	-1.014 (0.085)*	-1.046 (0.082)*	-1.046 (0.082)*	-1.039 (0.077)*	-1.757 (0.003)***
Lambda (λ)	0.578 (0.00)***	0.519 (0.00)***	0.517 (0.00)***	0.574 (0.00)***	0.741 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.822	0.814	0.813	0.823	0.809
Log Likelihood	192.630	185.023	184.824	193.628	172.193
AIC	-361.261	-346.047	-345.648	-361.255	-320.386
Breusch Pagan Test	44.007 (0.00)***	17.857 (0.085)*	23.347 (0.016)**	45.226 (0.00)**	80.690 (0.00)***
Wald Test	50.937	36.150	35.677	49.731	142.034
Likelihood Ratio Test	31.241 (0.00)***	24.063 (0.00)***	23.758 (0.00)***	30.806 (0.00)***	51.430 (0.00)***
LM Test	31.404	24.587	24.208	31.119	41.830

Table 8.4 shows the results from spatial lag specifications of models M1-M5 using QCO1 spatial weights and Table 8.5 shows the results from the spatial error specifications of models M1-M5 using QCO2 spatial weights, with both sets of models using a maximum

likelihood estimation procedure. The spatial component of the models, Wy in the spatial lag models of SM1-SM5 and λ in the spatial error models of SM6-SM10, is significant at a 99% confidence level across all of the spatial models, confirming the need to use spatial econometric methods. This is reaffirmed by the highly significant Likelihood Ratio test statistics across all of the models, suggesting greater explanatory power in the models that include a spatially autoregressive component. The spatial diagnostic tests, in the form of the Wald (W), LR and LM test statistics follow the desired order, W>LR>LM, across all of the models except SM6 and SM7; however, using spatial lag specifications for these models is no more satisfactory in this regard, suggesting that other spatial issues are present in the models. The AIC suggests that the explanatory power of all of the spatial models is greater throughout SM1-SM10 in comparison with their OLS counterparts. Furthermore, the AIC is minimised in the spatial lag models using QCO1 spatial weights, suggesting that the spatial lag models of SM1-SM5 have more explanatory power. Finally, the highly significant Breusch Pagan tests indicates that heteroskedasticity is still present in most models even with the inclusion of a spatially autoregressive component. The same software issues were present in the computation of these models as were experienced in the previous chapter, such that computing heteroskedasticity standard errors was not possible with a ML estimation procedure that also produced the required model statistics. Accordingly, models SM1-SM10 with heteroskedasticity consistent standard errors using a 2SLS estimation procedure can be found in the Appendix (A31). Despite the use of a different estimation procedure with adjusted standard errors, the interpretive significance of the estimated coefficients remains largely the same.

With the exception of the age related variables, the statistical significance of the variables in the spatial models SM1-SM10 is largely the same as their OLS counterparts. This provides stronger evidence that a greater concentration of graduates and an ethnically diverse regional population are particularly conducive to local entrepreneurship, adding to the inductive strength of these arguments. Interestingly, the NOQUAL variable is estimated to be positive and significantly different from 0 at a 95% confidence level in SM4 and SM5 when tested simultaneously with the DEGREE variable, a result that is particularly counterintuitive given the theoretical constructs regarding entrepreneurial ability. The statistical significance of the estimated coefficients of the control variables remains the same throughout all of the models SM1-SM10.

In comparing the spatial lag models SM1-SM5 of with their OLS counterparts M1-M5, one interesting difference can be seen regarding the nature of the relationship between experience and entrepreneurship. First, it can be observed that the estimated coefficient of the PERC2534 variable is negative and significantly different from at a 95% confidence level in SM2 and SM3 and at a 99% confidence level in SM1, SM4 and SM5. This provides further evidence that people aged 25-34 may not have yet acquired the experience necessary to successfully recognise and appropriate entrepreneurial opportunities. Further evidence of the positive relationship between experience/entrepreneurial ability and entrepreneurship can be seen by the positive and significant coefficient of the PERC5064 variable through SM1-SM3, and all spatial models SM1-SM5 with heteroskedasticity consistent standard errors (Appendix: A31). This suggests that regions with a higher concentration of people aged 50-64 also tend to exhibit higher firm birth rates, *ceteris paribus*. When analysed in conjunction with the negative and significant coefficient of the PERC2534 variable and the insignificant coefficient of the PERC3549 variable, this might suggest that the probability of entering into entrepreneurship is an increasing linear function of age, as opposed to an 'inverse U' shaped function (Bönte, Falck and Heblich, 2009; Wennekers*, et al.*, 2005). However, this interpretation is tentative as the estimated coefficient of the PERC5064 variable is only significantly different from 0 at a 90%, and this significance disappears with the use of QCO2 spatial weights in spatial models SM6-SM10 displayed in Table 8.5. Aside from this, the statistical significance of the estimates of SM1-SM5 using QCO1 spatial weights and SM6-SM10 using QC02 spatial weights remain broadly the same, with little quantitative difference between the estimates being observed when these different spatial weights are used.

8.7 – ML Spatial Regression Models with Nearest Neighbour Spatial Weights

Table 8.6. Spatial lag models of M1-M5 using 4NN spatial weight matrix. Dependent variable: LNFB1000. No. of observations = 408.

	SM11	SM12	SM13	SM14	SM15
Constant	0.577 (0.001)***	0.499 (0.075)*	0.547 (0.003)***	0.535 (0.003)*	0.583 (0.002)
% of regional population who hold a degree (DEGREE)	0.0049 (0.00)***			0.0063 (0.00)***	0.011 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0007 (0.771)			
% of regional population who have no educational qualifications (NOQUAL)			0.0019 (0.506)	0.0067 (0.030)**	0.007 (0.029)**
% of regional population 16+ aged 25-34 (PERC2534)	-0.011 (0.002)***	-0.0079 (0.020)**	-0.0080 (0.019)**	-0.012 (0.001)***	-0.0105 (0.004)***
% of regional population 16+ aged 35-49 (PERC3549)	0.0015 (0.634)	0.0009 (0.780)	0.0008 (0.798)	0.0015 (0.623)	0.0092 (0.002)***
% of regional population 16+ aged 50-64 (PERC5064)	0.0061 (0.126)	0.0062 (0.128)	0.0058 (0.154)	0.0052 (0.198)	0.0089 (0.032)**
Ethnic Diversity Index (ETHDIV)	0.089 (0.00)***	0.099 (0.00)***	0.095 (0.00)***	0.084 (0.00)***	0.086 (0.00)***
Employment Density (EMPDENS)	0.00002 (0.00)***	0.00002 (0.00)***	0.00002 (0.00)***	0.00002 (0.00)***	0.00002 (0.00)***
Public Sector Employment (PSEMP)	-0.972 (0.00)***	-0.897 (0.00)***	-0.876 (0.001)***	-0.945 (0.00)***	-1.080 (0.00)***
Claimant Rate (CLAIMRATE)	-0.053 (0.00)***	-0.066 (0.00)***	-0.072 (0.00)***	-0.064 (0.00)***	-0.072 (0.00)***
Median Incomes (INCOME)	0.0011 (0.00)***	0.0014 (0.00)***	0.0014 (0.00)***	0.0011 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.057 (0.004)***	-0.053 (0.008)***	-0.054 (0.006)***	-0.062 (0.002)***	-0.061 (0.003)***
City of London Dummy (LONDUM)	0.940 (0.127)	0.789 (0.204)	0.771 (0.214)	0.945 (0.123)	0.647 (0.309)
W_LAG LNFB1000	0.326 (0.00)***	0.321 (0.00)***	0.323 (0.00)***	0.331 (0.00)***	0.390 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.831	0.827	0.827	0.833	0.816
Log Likelihood	206.502	201.103	201.282	208.853	186.901
AIC	-387.004	-376.207	-376.565	-389.706	-347.802
Wald Test	67.805	64.048	64.510	70.3342	99.614
LM Test	63.00	59.77	60.16	65.404	83.727

Table 8.7. Spatial error models of M1-M5 using 8NN spatial weight matrix. Dependent variable: LNFB1000. No. of observations = 408

	SM16	SM17	SM18	SM19	SM20
Constant	1.019 (0.00)***	0.931 (0.001)***	0.959 (0.00)***	0.958 (0.00)***	1.380 (0.00)***
% of regional population who hold a degree (DEGREE)	0.0061 (0.00)***			0.0073 (0.00)***	0.012 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0005 (0.834)			
% of regional population who have no educational qualifications (NOQUAL)			0.0015 (0.611)	0.0065 (0.041)**	0.0058 (0.078)*
% of regional population 16+ aged 25-34 (PERC2534)	-0.0068 (0.046)**	-0.0033 (0.326)	-0.0033 (0.336)	-0.0072 (0.035)**	-0.0087 (0.014)**
% of regional population 16+ aged 35-49 (PERC3549)	0.0027 (0.394)	0.0018 (0.562)	0.0019 (0.556)	0.0030 (0.337)	0.0057 (0.070)*
% of regional population 16+ aged 50-64 (PERC5064)	0.0077 (0.048)**	0.0074 (0.063)*	0.0072 (0.071)*	0.0071 (0.065)*	0.010 (0.017)**
Ethnic Diversity Index (ETHDIV)	0.077 (0.00)***	0.087 (0.00)***	0.084 (0.00)***	0.072 (0.00)***	0.051 (0.015)**
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-0.812 (0.002)***	-0.784 (0.003)***	-0.779 (0.003)***	-0.812 (0.002)***	-0.812 (0.002)***
Claimant Rate (CLAIMRATE)	-0.064 (0.00)***	-0.080 (0.00)***	-0.084 (0.00)***	-0.074 (0.00)***	-0.084 (0.00)***
Median Incomes (INCOME)	0.0012 (0.00)***	0.0015 (0.00)***	0.0015 (0.00)***	0.0012 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.088 (0.00)***	-0.087 (0.001)***	-0.089 (0.001)***	-0.095 (0.00)***	-0.090 (0.002)***
City of London Dummy (LONDUM)	-0.868 (0.115)	-0.806 (0.152)	-0.801 (0.154)	-0.869 (0.113)	-1.378 (0.012)**
Lambda (λ)	0.633 (0.00)***	0.615 (0.00)***	0.615 (0.00)***	0.634 (0.00)***	0.737 (0.00)***
P-values to coefficient t-statistics given in brackets. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.788	0.787	0.787	0.790	0.721
Log Likelihood	206.482	198.94	199.102	208.561	191.242
AIC	-388.964	-373.989	-374.203	-391.122	-358.483
Wald Test	114.362	100.982	101.023	114.811	244.829
LM Test	83.75	72.70	73.32	87.152	109.404

Tables 8.6 and 8.7 summarise the results of a ML estimation of the appropriate spatial specifications of models M1-M5 using 4NN and 8NN spatial weights, respectively. As indicated previously, the LM spatial diagnostic tests of OLS models M1-M5 (Appendix: A30) indicated the estimation of spatial lag models when using 4NN spatial weights and spatial error models when using 8NN spatial weights. First, it can be seen that the spatial

lag component of SM11-SM15 and the spatial error component of SM16-SM20 is highly significant across all models; this suggests the presence of spatial autocorrelation within the data and highlights the need for utilising spatial econometric methods when proximity based spatial weights are used. In comparison with their OLS counterparts, AIC confirms that the inclusion of a spatially autoregressive component increases the explanatory power of the models. Furthermore, in comparison with their analogous models of SM1-SM10 using contiguity based spatial weights, the AIC is minimised in models SM11-SM20, suggesting that using spatial weights based on proximity provide spatial models with greater explanatory power compared to the OLS models and the spatial models with contiguity based spatial weights. Unfortunately, software limitations precluded the computation of LR tests in spatial models using proximity based spatial weights; however, the Wald test statistic and LM test statistics are still presented, and it can be seen that W>LM across all models SM11-SM20. In the absence of the LR test, further tests for spatial dependence, in the form of the Anselin-Kelejian test, were carried out on models SM11-SM15 that used a two-stage least square estimation procedure (Appendix: A32); it can be seen that the spatial lag specification using 4NN spatial weights eliminates spatial dependence issues within the data, such that all of the models SM11-SM15 (Appendix: A32) pass the Anselin-Kelejian test. All of the models SM11-SM20 were re-estimated using a two-stage least squares estimation procedure with heteroskedasticity consistent standard errors as a precautionary measure (Appendix: A32); the statistical significance of the estimated coefficients remains the same with the use of either the adjusted or non-adjusted standard errors, adding to the robustness of the results.

Again, it appears the use of spatial models makes little qualitative difference to the statistical significance of the estimated coefficients of the explanatory variables. Both the DEGREE and ETHDIV variables are positive and significantly different from 0 at a 99% confidence level across all of the models SM11-SM20. This reiterates that a higher local concentration of graduates and an ethnically diverse local population is conducive to local entrepreneurship. Moreover, SM14, SM15, SM19, and SM20 reinforce the earlier results of SM4 and SM5, as they imply a positive and statistically significant relationship between the

NOQUAL variable and regional firm births. This suggests that a greater regional concentration of people lacking formal education qualifications tends to be associated with higher regional firm birth rates, *ceteris paribus*. This is a generally counterintuitive result and possible reasons for this are discussed in Section 8.8.1. The main difference observed between the models SM11-SM20 and their OLS counterparts M1-M5 again concerns the age related variables. The estimated coefficient of the PERC2534 variables is again estimated to be negative and significantly different from 0 at a 95% confidence level across SM12 and SM13 and at a 99% confidence level in SM11, SM14, and SM15. This relationship is less consistent across SM16-SM20, but still provides further evidence that a younger regional population is typically less entrepreneurial. Furthermore, the use of 8NN spatial weights in the spatial error models SM16-SM20 provides tentative evidence that the probability of entering into entrepreneurship is an increasing linear function of age, as the estimated coefficient of the PERC5064 variable is estimated to be positive and significantly different from 0 across these models; however, the lack of significance observed in the spatial lag models SM11-SM15 when 4NN spatial weights are used detracts from the strength of this interpretation. Finally, the statistical inference of the estimates of the control variables remain the same as in the previous spatial models

Overall, the spatial specification of the models produces estimates that are largely the same as the OLS models, such that spatial issues appear to be less of an issue in this chapter when compared to the models of the previous chapter. This could be attributed to how the different aspects of knowledge behave differently of space. Specifically, Cowan, David and Foray (2000) suggest that tacit knowledge, embodied within individuals in the form of education and expertise, diffuse less effectively over space than explicit/codified knowledge, the subject matter of the last chapter. As such, this might explain why little difference is observed between the OLS models and their spatial counterparts, as spatial issues are less relevant to spatial level data that seeks to measure tacit/embodied knowledge. Despite this, the regression results provide evidence of several interesting phenomena concerning the relationship between education, experience, and ethnic diversity and their effects on entrepreneurship, which will now be discussed in greater detail.

8.8 – Contextual Analysis

8.8.1 – Human Capital, Education, and Entrepreneurship

The main motivation for this chapter was to investigate whether a specific form of human capital endowment, entrepreneurial ability and tacit knowledge, has a positive influence on the entrepreneurial process. As education is a source of this human capital (Schultz, 1975; 1980) it was hypothesised that education may have a positive impact on the entrepreneurial process, in that regions with a more highly educated population are likely to have higher firm birth rates. The empirical results support this hypothesis, as the DEGREE variable is positive and highly significant across all of the models, being robust to both the inclusion of a spatial component, various spatial weights, and heteroskedasticity consistent standard errors. More specifically, an increased concentration of individuals with an advanced level qualification in the form of a degree appears to add to one's entrepreneurial ability such that it encourages entrepreneurship, given an exogenous opportunity set. This is in line with Audretsch and Keilbach (2004a), for example, who also find a significantly positive relationship between regional concentrations of university graduates and regional entrepreneurship. However, the NVQ1PLUS variable, used to approximate the attainment of a basic level of education, failed to provide evidence that supports this perspective. Perhaps counter intuitively, as far as the context provided by this thesis is concerned, the NOQUAL variable, used to approximate the absence of human capital across a regional population, appeared to have a positive effect on regional entrepreneurship across several of the spatial models.

Thus, increasing the university level education content of a population provides individuals with the ability to recognise entrepreneurial opportunities and appropriate them accordingly. At any given time any exogenous opportunity may exist but individuals may require advanced education to recognise it. Given an exogenous opportunity set, increasing the concentration of graduates within a regional population will increase the supply of potential entrepreneurs. In turn, this will lead to greater recognition of entrepreneurial opportunities and as result, a greater number of entrepreneurs will attempt to appropriate these opportunities through the creation of a new firm. Even if we consider the notion that the education attainment of an individual is a proxy of an individual's natural ability and the coefficient estimates may be a little biased with respect to the direct impact of education itself, the same inference still stands; an increase in entrepreneurial ability, shown through the university level educational attainment of a regional population, should correspond to an increase in entrepreneurship for a given set of opportunities.

The regression analysis presented here is unequivocal as far the relationship between university education and entrepreneurship is concerned. Furthermore, the results of several spatial models (SM4, SM5, SM14, SM15, SM19, and SM20) suggest that regional concentrations of people lacking formal educational qualifications (NOQUAL), when also controlling for concentrations of university graduates (DEGREE), has a positive effect on regional entrepreneurship. There is precedence in the empirical literature regarding the positive impact of a higher concentration of graduates on local entrepreneurship, as well as the positive relationship observed between concentrations of people who lack formal education qualifications and local entrepreneurship. For example, Armington and Acs (2002), using a similar methodological approach, attempt to measure the impact of an increased regional share of college graduates and people lacking a high school diploma on firm birth rates, similar to the DEGREE and NOQUAL variables used here. Their results are also unambiguous in their suggestion that an increased share of university graduates at regional level is associated with significantly higher local firm birth rates. Interestingly, their results also highlight the effects that a lack of educational qualifications held by a regional population can have on local entrepreneurship; an increased share of the regional population who lack a high school diploma has a positive and significant effect on firm births when included with the college graduate variable, analogous to some of the results presented here. This finding is justified by Armington and Acs (2002) by highlighting that the 'no high school diploma' variable is highly correlated with the 'college graduate variable' and, when both are controlled for, the positive and significant coefficients highlights the fact that new firms need unskilled labour. All of the results presented here reaffirm the empirical results of Armington and Acs (2002), in that local concentrations of university graduates are conducive to local entrepreneurship; moreover, the results of SM4, SM5, SM14, SM15, SM19, and SM20, showing a positive relationship between NOQUAL and regional entrepreneurship, also supports Armington and Acs' (2002) results and their suggestion that new firms need unskilled labour. An alternative interpretation of the positive estimated coefficient of the NOQUAL variable in these models is to suggest that, as a result of lacking formal education qualifications, these individuals opt for entrepreneurship due to poor paid employment opportunities. This interpretation fits into the theories of 'push factors' in determining entrepreneurial behaviour (Storper and Scott, 2009) and occupational choice models (Kihlstrom and Laffont, 1979). For example, in weighing a certain wage against a risky profit, individuals lacking formal education qualifications, in particular, might consider that the prospect of a sufficient wage is suitably low that they would rather take the risks of attaining profit through entrepreneurship. Consequently, this suggests that entrepreneurship is an option for individuals with both a high and low human capital endowment, but for varying reasons; individuals with a high human capital endowment might choose entrepreneurship because they are better able to, whereas individuals with a low human capital endowment might choose entrepreneurship due to a lack of suitable employment alternatives.

Furthermore, the lack of significance observed with the estimated coefficients of the NVQ1PLUS variable, used to approximate the attainment of basic education, also has precedence in some empirical studies. For example, Shane (1996) finds no evidence of a positive influence from higher concentrations of high school graduates on entrepreneurship. Comparing people with NVQ qualifications in the UK with high school graduates in the US might seem questionable, but they are effectively approximating the same phenomenon within a population: the attainment of 'basic' education. Thus, the lack of significance observed here reaffirms the result of Shane (1996) and perhaps reiterates that it is only advanced, university level education that significantly increases entrepreneurial ability. Interestingly, in comparison to the positive effects of the DEGREE and NOQUAL variables in some of the spatial models, this might suggest that those with intermediate levels of human capital are least like to behave in an entrepreneurial manner and start a firm.

It is plausible that the nature of university education, in particular, might encourage entrepreneurial behaviour as it fosters psychological characteristics that are conducive to entrepreneurship. For example, universities emphasise independence in the learning process with material and teaching methods that are typically less guided, structured or standardised than other forms of education; it is plausible that this might foster a sense of individualism amongst university students that is crucial to an entrepreneurial orientation that other forms of education do not. Whilst this is conjecture that the empirical results presented here cannot directly answer, it remains clear that university education is conducive to entrepreneurial behaviour, however this process might occur. This is, however, echoed by Pickernell*, et al.* (2011), who argue that higher education (HE) "is critical in developing the levels of motivation and capabilities of graduates to effectively engage in entrepreneurship".

Alternatively, it is also plausible to view these results from a KSTE perspective and from a perspective that considers an individual's endowment of tacit knowledge, and how this impacts their recognition of an entrepreneurial opportunity. Educated individuals arguably harbour a greater quantity of tacit knowledge that would be relevant to the appropriation of a knowledge intensive opportunity, such as a technological innovation, due to the increased likelihood that they (i) were involved in the development of this opportunity through employment in KBIs or (ii) have a greater understanding of the potential applicability of a certain entrepreneurial venture to this given opportunity. Point (i) is effectively a re-statement of the concepts involved in the KSTE, particularly relevant given that KBIs are defined as such according to the number of graduates that they employ.

Point (ii) is relevant if the entrepreneur becomes ‘aware’ of the entrepreneurial potential surrounding an opportunity and is closely related to Shane’s (2000) concept of the importance of ‘prior knowledge’ in determining the way in which an opportunity is appropriated. Greater tacit knowledge and prior knowledge within a regional population, both of which are measured by proxy using regional educational attainment, should correspond with an increased regional entrepreneurial tendency.

Thus, it appears that university graduates are particularly entrepreneurial and this point that has been recognised by policy makers (Smith and Beasley, 2011). For example, firm birth rates and business ownership is observed to be higher amongst graduates in comparison to non-graduates, and graduates are also more likely to be responsible for the fastest growing firms, to the extent that graduates have been described as “the entrepreneurs of the present and the future” (Smith and Beasley, 2011). Both university policy and public policy relating to higher education has increasingly emphasised the crucial roles that universities and higher education institutions can play in fostering entrepreneurship amongst graduates (Pickernell*, et al.*, 2011), such that ‘business and enterprise development’ has been a key strategic goal for British universities (Smith and Beasley, 2011). As an example of how universities can encourage entrepreneurship to achieve these aims, Smith and Beasley (2011) highlight that sector specific support services provided by HE institutions can act as a key ‘enabler’ of entrepreneurship amongst students and graduates, particularly through the “encouragement, ‘intense’ business advice, and support”, as well as the provision of micro-finance. Thus, the observed positive and significant relationship between regional concentrations of graduates and regional firm birth rates possibly suggest that these policies have been particularly successful in encouraging entrepreneurship amongst graduates. Of course, any confirmatory empirical evidence would need to investigate how this relationship has evolved over time.

The entrepreneurial tendency of graduates has several implications for policy makers. Current policy that seeks to encourage entrepreneurship, such as the ‘Start-Up

Britain[15]' initiative (Centre for Entrepreneurs, 2014), might be even more effective if it were targeted at HE students and graduates, possibly through conducting a greater number of events through universities. Furthermore, such policies may be more effective if HE institutions are provided with the means to deliver sector specific business support services for students and graduates seeking to become entrepreneurs. In conjunction with this, policymakers might also look to widen university participation in order to encourage entrepreneurial behaviour with the economy; these policies may increase the supply of entrepreneurs and encourage entrepreneurial activity. Widening participation in HE has been an aspect of HE policy since at least the 1960's and particularly since the election of the Labour government in 1997, who established a "50% participation target" (David*, et al.*, 2008). The changing policy contexts that sought to widen participation did so to increase individual and social mobility (David*, et al.*, 2008); however, the results presented here suggest that it might be beneficial to widen participation in order to promote entrepreneurship amongst future graduates.

Related to this final point are potential societal welfare gains from widened university participation, accrued from the fact that university graduates appear to be typically more entrepreneurial, which is linked to the wider discussion of private and social rates of return to university education. This is currently a particularly pertinent issue in the UK given the recent and somewhat controversial reforms of tuition fees and student finance. Card (2001) highlights the resurgence of research into the causal links between education and 'labour market success' and that this renewed interest "stems from the rise in the 'return' to education, especially in the US labour market, and the growing disparities between the more and less educated workers" (Card, 2001). Most work that investigates returns to education generally focuses on determining why and by how much people invest in their education in order to maximise the "discounted present value of earnings" and "accrue a flow of utility at time t" (Card, 2001). Psacharopoulos and Patrinos (2004)

[15] The 'Start-Up Britain' initiative is a national campaign organised by the Centre for Entrepreneurs (CfE). The CfE comprises of several private sector companies backed by the UK government and looks to encourage enterprise throughout the UK, offering assistance and advice to nascent entrepreneurs through workshops and seminars.

suggest there is further concern in the literature with the lack of accurate estimations of what might be called ‘social rates of return to education’ that include true social benefits or externalities: “in the case of education some succeeded in identifying positive externalities, however a recent review suggests that empirical evidence is scarce and inconclusive” (Psacharopoulos and Patrinos, 2004). The results of the preceding regression analysis would seem to suggest that ‘social rates of return’ to university education might be rather high due to the increased entrepreneurial activity of university graduates, as this may indirectly create positive externalities in the form of economic growth and job creation. The presence of these social returns would suggest that, from a social welfare perspective, investment in education is likely to be sub-optimal if these forms of social returns are not considered, thus advocating public investment in education in order to fully realise these returns.

8.8.2 – Labour Market Experience and Entrepreneurial Ability

Regarding the accumulation of human capital through experience, some interesting results are observed. Entrepreneurial ability or tacit knowledge is enhanced by experience in the labour market through a process of “learning by doing” (Arrow, 1962a), implying that the embodiment of entrepreneurial ability or tacit knowledge will increase with the age of an individual, *ceteris paribus*. However, this relationship might not be linear as it is theorised, and somewhat empirically verified, that there exists an ‘inverse U’ shaped relationship between age and the likelihood of engaging in entrepreneurship (Parker 2004, cited in Bönte, Falck and Heblich (2009). This corresponds to a ‘peak age’ of about 40 for the entrepreneur, where the balance between experience and occupational preference in the form of entrepreneurship is optimal. Nonetheless, the age structure of a regional population was hypothesised to have a significant impact on entrepreneurship and this was found to a certain extent by the regression results. In particular, several of the regression models suggest that a younger regional population implies lower firm birth rates, *ceteris paribus*; this may be because a younger local population may lack the entrepreneurial ability accrued from labour market experience that might be necessary to behave entrepreneurially. Several of the spatial models suggest that an older yet still economically active population exhibits significantly higher firm birth rates, *ceteris paribus*; consequently, it may be argued that this particular age cohort has acquired the requisite entrepreneurial ability through their longer labour market participation. Furthermore, the general insignificance of the estimated coefficient of the middle age cohort in these models suggests that a positive linear relationship can be expected between age and proclivity towards entrepreneurship. Finally, some evidence is presented of the presence of the 'inverse U' shaped relationship (Bönte, Falck and Heblich, 2009) between age and probability of entering into entrepreneurship in the OLS model that excludes the INCOME variable (M5); however, as this is only in the one model, this evidence is decidedly weak. Generally, a broad conclusion from the results is that the probability of starting a firm generally increases with age, but that the strength of this inference is weakened by the sensitivity of the age related variables to other explanatory variables in the model and the spatial specification of the models.

Despite the lack of evidence for the 'inverse U' shaped relationship in the models, the results generally confirm that age structure has a significant impact on regional entrepreneurship. Regarding the reasons why this relationship exists, a compelling case can be made for attributing it to the increase in entrepreneurial ability or tacit knowledge that accrues with experience. Specifically, as people accrue experience in the labour market over time, they accumulate human capital in the form of entrepreneurial ability and tacit knowledge that allows them to recognise entrepreneurial opportunities and appropriate them accordingly.

The finding that the age structure of a regional population can have a significant impact on regional entrepreneurial activity is in accordance with other research on the topic such as Reynolds, Miller and Maki (1995), Shane (1996), and Bönte, Falck et al. (2009). All three of these pieces highlight the significant effect of regional age structure on regional entrepreneurship. Shane (1996) finds that an increased concentration of 25-34 years olds can have a significant effect on entrepreneurship, although this effect is somewhat ambiguous and the estimates are sensitive to the inclusion of other explanatory variables. Similarly, Reynolds, Miller and Maki (1995) find that an increased concentration of 'well educated, 25-45 year olds' has a positive impact on entrepreneurship. Given the results here and previous empirical findings, one must agree with Reynolds, Miller et al. (1995) when they suggest that age must be "an important precursor of firm births, deaths and turbulence [and that] it is hard to avoid assumptions that this [age] index was related to pools of adults that were the source of teams starting new firms."

Alternatively, it should be noted that the tendency towards entrepreneurship that appears to accompany an increase in age may be affected by other factors associated with age, such as availability of start-up capital, both social and financial. Regarding the former, Bönte, Falck et al. (2009) discuss how social capital, in the form of denser social and peer networks, increases with age and how this can benefit nascent entrepreneurs in two fundamental ways: first, by facilitating access to resources, such as capital and labour, which are required to start a firm, and second, due to the fact that "both personal and informal business contacts provide information about opportunities and risks, thus reducing both transaction costs and uncertainty" (Bönte, Falck et al. 2009). Evans and Jovanovic (1989), in discussing the influence of liquidity constraints on entrepreneurship, argue that "entrepreneurship may in fact not be an option for younger workers because they will have had less time to build up the capital needed to start a business and, with liquidity constraints, will have difficulty borrowing enough start-up funds" (Evans and Jovanovic, 1989: 809). The results of the models that exclude the INCOME variable (M5, SM5, SM10, SM15, and SM20) arguably demonstrate that the time taken to accumulate the necessary financial start-up capital can have a significant impact on entrepreneurial activity. The positive and highly significant coefficients of the PERC3549 and PERC5064 variables in the models excluding the INCOME variable become much less significant when income is controlled for, as discussed in greater detail earlier. Therefore, the interaction between age and income in these models might suggest that the significance observed on estimated coefficients of the older age cohort variables can be attributed to the time needed to accumulate financial capital. These points provide persuasive alternative explanations of the empirical findings. However, given that the age variables still show significant estimated effects when income is controlled for, there remains evidence that the regional age structure of the population can have a significant impact on regional firm birth rates.

Understanding that regional entrepreneurship can be influenced by regional demographics can be a useful tool for policy makers seeking to encourage entrepreneurship. For example, if 50-64 year olds are more likely to start a firm, public policy seeking to encourage entrepreneurship could be better focused and perhaps more effective if it addresses the specific barriers that are typically faced by nascent entrepreneurs in this age range. However, such an approach may exacerbate regional inequalities in entrepreneurship, as data presented earlier showed some very noticeable and statistically significant patterns regarding the spatial distribution of certain age cohorts across GB. For example, London and other urban centres were shown to have particularly young population, whereas peripheral regions, such as the South West and the north of England, had typically older populations (Appendix: A21, A22, A23, and A24); moreover, this spatial variation is seen to be persistent over time (Appendix: A25, A26, and A27). Interestingly, the data also highlights the economic dynamism of London, in that despite having a persistently younger age demographic that might diminish entrepreneurial activity, London still exhibits higher than average firm birth rates. This suggests that London may get its entrepreneurial vigour from sources other than age dynamics and is demonstrative of the balance of economic contexts that influence the entrepreneurial process on a spatial level. Pursuing a course of action that sought to encourage entrepreneurship within the more entrepreneurially inclined age groups could either exacerbate or maintain the regional inequalities seen in entrepreneurship. As several key economic variables are influenced by entrepreneurial activity, it would follow that such policy could also exacerbate regional inequalities in incomes and prosperity, thus having an impact on regional convergence. More research providing insights into the age specific barriers that people face when considering starting a firm and faced with the opportunity to do so could direct policy on how to address regional inequalities in entrepreneurship that stem from the spatial distribution of people within different age cohorts.

8.8.3 – Ethnic Diversity and Entrepreneurship

It was hypothesised that some entrepreneurial opportunities would only be recognised by individuals of a certain ethnic persuasion as they would have the knowledge and abilities necessary from their cultural experience; an ethnically diverse regional population increases the likelihood of these knowledge and abilities being present. Estimating the impact of ethnic diversity on entrepreneurship also has precedence in the literature (Bishop, 2012; Levie, 2007), and is also related to Florida's (2002; 2004, cited in Storper and Scott, (2009)) concept of the creative class in urban centres. The general hypothesis that emerges is that ethnic diversity in a region should have a positive impact on entrepreneurship, and the regression models presented in this chapter support this. Moreover, there is also a significant spatial spillover effect present, such that the ethnic diversity of a population in neighbouring regions can also positively influence regional entrepreneurship.

These results are in accordance with other research that has attempted to estimate the effect of diversity, be it ethnic, social, or industrial, on entrepreneurship. For example, Audretsch and Keilbach (2007) find that the diversity of human capital has a significant impact on entrepreneurship and that social diversity is conducive to high technology entrepreneurship. Reynolds, Miller and Maki (1995) also show that both social and ethnic diversity is positively associated with entrepreneurship, albeit to a more 'minor' level than some of their other explanatory variables. There is certainly some solid empirical evidence that diversity across a population is beneficial to the rate of entrepreneurship.

There are several possible reasons as to why this would be the case. First, there is the idea that the creation and perception of certain entrepreneurial opportunities is uniquely available to a subset of the population who are of a certain ethnic persuasion, as espoused by Reynolds, Miller and Maki (1995): "as diversity increases, there is a wider range of demand for goods and services and, in turn, more diverse opportunities for new and small firms." To put this within the context of this chapter, the recognition of these opportunities, however they exist, would be dependent on ethnicity specific tacit knowledge endowed within individuals. The marriage of the opportunity and the ethnically diverse individual within this context would lead to greater regional firm birth rates. Second, other studies (Levie, 2007) have shown ethnic minorities are likely to resort to self-employment entrepreneurship as a result of racial discrimination in the labour market, possibly in the form of greater difficulty in securing employment or discrimination in securing borrowed finance. Levie (2007) argues using evidence from the US that "ethnic minority individuals may counter resource acquisition disadvantage by utilising networks in ethnic minority enclaves"; however, it is thought that this solution is "sub-optimal". Clearly, if labour market discrimination is a source of entrepreneurship in ethnically diverse areas, and this outcome is 'suboptimal' from a social welfare perspective, then this suggests that more needs to be done at national and local government level to combat discrimination against ethnic minorities in the labour market. This is notwithstanding the fact that there is a positive outcome from this labour market discrimination in the form of greater rates entrepreneurship.

The third explanation of why ethnically diverse regional populations are more entrepreneurial relates to Florida's (2002, cited in Storper and Scott, 2009) theory of the 'creative class'. The 'creative class', ones who "add economic value through their creativity" in the form of "high levels of innovation and expansion of creative and technology–intensive sectors", congregate geographically due to the presence of a specific local amenity: tolerance. This local tolerance is generally indicated through the ethnic diversity of the local population and the "accumulation of [creative] human capital in these places incites creativity (through interaction)" (Storper and Scott, 2009), manifesting itself in higher levels of entrepreneurship. In this sense, ethnic diversity measures act as a proxy variable for the presence of the 'creative classes' in a region, and therefore the statistical significance of the ethnic diversity index can partly be attributed to an omitted variable bias.

It could be recommended that in order to truly capture the specific effect of ethnic diversity on entrepreneurial activity, the presence of the ‘creative class’ will need to be controlled for explicitly as an explanatory variable; this is a recommendation for future research. Relating diverse urban populations to creativity dates back to Tönnies’ (1887) ‘classic of urban sociology’, where it is claimed that it is the “climate of openness in cities that frees individuals from the chains of tradition or anxieties about being judged, and that encourages people to be more imaginative and inventive” (Storper and Scott, 2009).

In general, the regression results presented here echo the assertion of Smallbone, Kitching and Athayde (2010) who suggest that “an ethnically diverse society is potentially economically stronger than a less diverse one”, due to local ethnic minorities being a potential source of local competitiveness as a result of their entrepreneurial activity. This inference is attractive, as it provides the justification to implement policies encouraging entrepreneurship amongst minorities under the auspice of encouraging welfare gains for the society as a whole (Smallbone, Kitching et al. 2010). Obvious consequences of the positive influence of ethnic diversity on societal welfare include the possible reduction of social tensions that can sometimes accompany the influx of migrant populations.

8.9 – Conclusion

This chapter has sought to show how the idiosyncratic knowledge and understanding of individuals influences their proclivity towards entrepreneurship from two related perspectives. First, it considers how tacit knowledge might influence the recognition and exploitation of entrepreneurial opportunities. Second, it sought to investigate how entrepreneurial ability can positively influence the entrepreneurial process. Both tacit knowledge and entrepreneurial ability can be considered specific forms of human capital that are enhanced by a myriad of factors relating to education, experience, and ethnic background. An approach that takes the opportunity as exogenously given and the entrepreneur existing endogenously through their knowledge and ability contrasts with the previous chapter, which sought to analyse the regional factors that endogenously created opportunities exploited by exogenously existing entrepreneurs. The justification for applying a more 'traditional' approach, by focusing on the idiosyncratic characteristics of the 'entrepreneur', to complement the findings of the previous chapter is perhaps best summed up by (Reynolds, Miller and Maki, 1995): "new firms are… started by people, not regional factors."

The regression analysis presented in this chapter aimed to investigate how educational attainment, regional age structure, and ethnic diversity influenced firm birth rates, whilst controlling for other factors relating to agglomeration externalities, barriers to entrepreneurship, unemployment, incomes, and OIRs. There were several conclusions that can be drawn from the results. First, there is evidence that the educational attainment of a regional population can have a significant effect on regional entrepreneurship; specifically, regions with a greater concentration of university graduates exhibit greater levels of entrepreneurial activity. This finding supports the theories that tacit knowledge and entrepreneurial ability, acquired through university education, positively influence the entrepreneurial process by providing individuals with the capacity to discover and exploit entrepreneurial opportunities. Second, there is evidence to suggest that labour market experience can also encourage entrepreneurship amongst individuals through enhancing their tacit knowledge and entrepreneurial ability. This inference mainly stems from the estimates that suggest concentrations of people aged 25-34 have a negative effect and concentrations of people aged 50-64 have a positive effect on regional entrepreneurship. It can be suggested from this that the relationship between experience and the probability of entering into entrepreneurship is positive and linear, as opposed to the 'inverse U' shaped relationship proffered by some (Bönte, Falck and Heblich, 2009). Evidence regarding the positive effect of labour market experience on entrepreneurship is decidedly weaker and possibly suggests that education may be a greater source of entrepreneurial ability. However, it may still be concluded that the age structure of a regional population can have a significant impact on regional entrepreneurial activity. There is also particularly robust evidence to suggest that an ethnically diverse regional population is particularly entrepreneurial; in the context of this chapter, it might be suggested that some entrepreneurial opportunities can only be recognised by those who have ethnicity specific knowledge, and an increase in the ethnic diversity of a regional population increases the probability of that knowledge being present. Finally, the range of control variables used in the models presented here reinforce the results of the previous chapter and provided further, more robust evidence of their respective effects on regional entrepreneurial activity.

In summary, the results of the regression analysis are supportive of the notion that individuals with a greater degree of tacit knowledge and entrepreneurial ability, enhanced by education and experience, are more likely to engage in entrepreneurship. The implications of these findings are important, ranging from how we perceive positive externalities from investment in education, to the consequences of the persistent nature of the spatial distribution of certain age groups across GB. These contextual considerations, as well as some minor policy related guidance, are discussed in the conclusion.

9

Chapter 9 – Conclusion

9.0 – Introduction

This thesis has sought to provide a comprehensive empirical investigation of entrepreneurship within the KBE, utilising a variety of ESDA and spatial econometric techniques on newly available data on firm births across GB between 2008 and 2010. Following a discussion of the various approaches to entrepreneurship in the economics literature and the epistemological and methodological issues regarding the study of entrepreneurship, the empirical analysis focussed on two theories of entrepreneurship that emphasise the role of knowledge in the entrepreneurial process. First, the KSTE (Acs*, et al.*, 2009) posits that the production of new knowledge creates entrepreneurial opportunities, such that regions which produce more knowledge through the presence of appropriate institutions and knowledge intensive industries should be more entrepreneurial. Second, several approaches to entrepreneurship posit that certain cognitive abilities (Schultz, 1975; 1980) and prior knowledge (Shane, 2000) are vital in the recognition and appropriation of entrepreneurial opportunities, such that regional populations endowed with greater levels of human capital should be more entrepreneurial. These two approaches also analyse different aspects of the dichotomous nature of knowledge (Cowan, David and Foray, 2000), specifically that explicit/codified knowledge creates entrepreneurial opportunities and tacit/embodied knowledge is responsible for their recognition. Furthermore, the nature of explicit and tacit knowledge suggests that they might behave differently over space (Döring and Schnellenbach, 2006), necessitating empirical analysis of these knowledge based theories of entrepreneurship within a spatial context. The purpose of this chapter is to provide an overview of this analysis, summarising the key conclusions, the practical and policy implications of these conclusions, potential limitations, and opportunities for further research.

9.1 – Summary

Chapter 2 analysed entrepreneurship within early economics literature, highlighting a wide range of diverse approaches. Cantillon and Say emphasised the allocation of resources and factors of production to produce goods, whereas Mill emphasised the nature of entrepreneurial decision making in competitive markets. These approaches, as well as Marshall's, highlight the uncertainty inherent in the entrepreneurial process, in addition to the personality traits and abilities associated with entrepreneurship and dealing with uncertainty. These typically involve intelligence, judgement, foresight, and creativity.

An emphasis on decision making under uncertainty may explain why the assumptions of the neoclassical approach, and in particular general equilibrium analysis, marginalised entrepreneurship as a field of mainstream economic enquiry. Thus, the role of entrepreneurship is related to the philosophical core of economic methodology, where there appears to be a trade-off between the descriptive empirical realism of the classical approach and the logical coherence in the abstractions of the neoclassical approach; entrepreneurship has a greater role in the former. Alfred Marshall's approach does, however, provide an attractive medium between realism and logical coherence where entrepreneurial decision making has a role.

In light of the dominance of the neoclassical paradigm in economic thought throughout the twentieth century, several 'rival schools' and alternative approaches developed that considered entrepreneurship in economic affairs much more extensively. Chapter 3 discussed these approaches, specifically the theories of Joseph Schumpeter, Frank Knight and the Chicago School, and the Austrian School. These theories assigned to entrepreneurship a central role in economic development and the functioning of competitive markets. To Schumpeter, the entrepreneur implements 'new combinations' that destroy static conditions and this 'Creative Destructive' is responsible for economic development and the evolution of the capitalist system. The 'sister' Chicago and Austrian schools of thought mutually advocate "the universal beneficence of exchange, extreme individualism, and a doctrinaire advocacy of laissez-faire" (Hunt 1979:429). Furthermore, both of these schools of thought emphasise the role of uncertainty in economic affairs, and entrepreneurship is an expression of human agency in an 'open ended world', thus giving entrepreneurship a much wider philosophical significance.

Despite many attempts, economics still lacked a definitive theory of entrepreneurship by the latter half of the twentieth century. Whilst there were several reasons for this lack of consensus, scholars studying entrepreneurship began to reflect wider trends in economic epistemology and methodology through the application of empirical methods; several of these approaches were discussed in Chapter 4 and seek to explain the 'causes' of entrepreneurship within a deterministic framework. Despite some consistent aspects, such as uncertainty and profit, contrasting the theories of Chapters 2 and 3 suggests that the theoretical emphasis on the different facets of entrepreneurship depends on purpose, context, and methodological approach. Entrepreneurship is perhaps an allegorical concept that derives its definitional meaning from its association with a wide variety of factors. However, the empirical approaches required a practical definition of entrepreneurship through its manifestation in reality, to be utilised as a dependent variable in a deterministic model. This avoids the metaphysical arguments concerning what constitutes entrepreneurship and typically involves some measure of firm birth or organisation creation.

The latter two theories of entrepreneurship discussed in the Chapter 4, the KSTE and human capital approach, form the basis of this thesis, by providing various empirically testable hypotheses regarding the nature of the relationship between knowledge and entrepreneurship. These approaches to entrepreneurship are embedded within a spatial context as knowledge can be considered to diffuse imperfectly across space, such that it has a greater impact locally. Furthermore, the different forms of knowledge, explicit and tacit, also behave differently across space; the former is assumed to diffuse across space fairly freely, whereas the latter diffuses across space through labour mobility. Epistemological and methodological issues in economics, the relevance of empiricism to the study of entrepreneurship, and the methods and data to be used in the ESDA and spatial econometric analysis were discussed extensively in Chapter 5.

Chapter 6 provided an ESDA of firm birth rates in GB from 2008-2010, showing that entrepreneurial activity varies significantly across space. Specifically, there appeared to be a North/South divide, where regions in the south generally exhibit higher firm birth rates and the more peripheral regions of the North East of England, Scotland, and Wales tend to exhibit lower firm birth rates. Furthermore, the LISA statistics appear to show several statistically significant spatial regimes; London can be considered as an 'entrepreneurial regime, whereas several clusters of regions appear to constitute areas of significantly lower entrepreneurial activity and these regions are typically classed as OIRs. On the basis of these results, it was posited that the structural characteristics of these OIRs, in particular the possible lack of an adequate entrepreneurial culture, was worthy of further investigation in the forthcoming spatial econometric analysis.

Chapter 7 provided the first of the spatial econometric analyses, seeking to establish whether the production of explicit (scientific, codified) knowledge can be seen to create opportunities that are appropriated for profit by astute entrepreneurs, within the context stipulated by the KSTE. The results of the regression analysis are somewhat supportive of previous KSTE related research showing that the production of knowledge creates entrepreneurial opportunities and these opportunities are spatially bounded (Acs, *et al.*, 2009; Audretsch and Keilbach, 2007; Audretsch and Lehmann, 2005). This inference mainly came from the positive and statistically significant estimated coefficients on the patent intensity and KIMS employment variables; the other approximations of regional knowledge found no such relationship. Interestingly, diversity in employment across the knowledge intensive sectors, in both related and unrelated forms, has a consistently positive and significant impact on regional firm birth rates. These results indicate the presence of Jacobian externalities across knowledge sectors and accordingly, it can perhaps be concluded that diversity across these knowledge sectors is more conducive to creating entrepreneurial opportunities than employment outright. Moreover, these

Jacobian externalities are more likely to occur should the employment across knowledge based industries be in close proximity.

The series of controls in the models presented in Chapter 7 provided some interesting results. First, administrative and regulatory barriers from the public sector can have a detrimental effect on the entrepreneurial process; however this result is sensitive to spatial specification. Furthermore, evidence is also presented that shows the negative effect of regional unemployment on firm birth rates, possibly due to the pessimism regarding potential profit from entrepreneurial activity that might be associated with high regional unemployment, or due to the financial constraints faced by the unemployed. Related to this latter point is a similar inference regarding the effect of regional incomes on firm birth rates, as consistent evidence is found that regions with a higher median income are more likely to exhibit higher firm birth rates, *ceteris paribus*. This reaffirms the results of Bishop (2012) and Evans and Jovanovic (1989) that suggest that liquidity constraints are particularly detrimental to the entrepreneurial process, and that those with higher incomes face fewer resource constraints and a greater availability of start-up capital, thus encouraging local entrepreneurial activity. Finally, OIRs have significantly lower firm birth rates even when controlling for other structural factors, perhaps indicating the importance of a local entrepreneurial culture to the entrepreneurial process.

Having empirically investigated the main tenets of the KSTE, Chapter 8 analysed the relationship between human capital and entrepreneurship, specifically within the context of tacit knowledge and entrepreneurial ability. There is evidence that the educational attainment of a regional population can have a significant effect on regional entrepreneurship and that regions with a greater concentration of university graduates exhibit greater firm birth rates. This supports the suggestion that tacit knowledge and entrepreneurial ability acquired through university education provides individuals with the capacity to discover and exploit entrepreneurial opportunities. There is also evidence to suggest that labour market experience can encourage entrepreneurship amongst individuals, as it enhances their tacit knowledge and entrepreneurial ability. Furthermore, the relationship between experience and the probability of entering into entrepreneurship is positive and linear, as opposed to an 'inverted U' shaped relationship (Bönte, Falck and Heblich, 2009). However, this evidence is less robust and possibly suggests that education may be a greater source of entrepreneurial ability. Finally, there is particularly robust evidence to suggest an ethnically diverse population is typically more entrepreneurial, possibly because some entrepreneurial opportunities are only recognisable to those who have ethnicity specific knowledge.

9.2 – Broad Conclusions and Policy Implications

The empirical results of Chapters 7 and 8 provide important insights concerning the relationship between knowledge and entrepreneurship. First, the significantly positive effect that regional patent intensity has on regional firm birth rates is the strongest evidence supporting the *Endogenous Entrepreneurship Hypothesis* presented in Chapter 7. The similarly significant and positive effect of KIMS employment on regional entrepreneurship could also be interpreted in a similar fashion. However, the KIMS employment effect could also be attributed to the reduction in uncertainty surrounding how to appropriate an entrepreneurial opportunity that might accompany local employment in KIMS, as opposed to opportunities being explicitly created by KIMS. This is due to the fact that KIMS employment might create a regional knowledge stock that is conducive to the operation of businesses, through a greater presence of employment in consultancy and business support services for example. This is arguably evidence of how reducing uncertainty regarding the effective appropriation of an opportunity may encourage entrepreneurship, and is thus an integral component of the KSTE and the knowledge filter in particular. There is strong evidence that the tacit knowledge/entrepreneurial ability component of knowledge has a greater impact on regional entrepreneurship than the explicit form of knowledge in the KSTE context; a higher concentration of university graduates appears to have a positive and significant effect on firm birth rates throughout all of the models presented in Chapter 8. There is a very clear implication for policy makers, in that targeting graduates is likely to be an effective way of encouraging entrepreneurship. Furthermore, the general lack of significance observed on the age variables suggests that university education is a greater source of entrepreneurial ability than experience.

Comparing the insights of Chapters 7 and 8 suggests that there is an interesting dynamic between the interpretations of the KBI employment variables and the degree variable. KBIs are defined through their use of ICT and *employment of graduates*. However, with the exception of the KIMS variable, none of the KBIs had any statistically significant effect in the models of Chapter 7, whereas the degree variable was positive and statistically significant across all of the models of Chapter 8. By definition, employees in KBIs are essentially the same people as the resident university graduates and these two variables do indeed exhibit a strong positive correlation (0.627). There are at least two plausible reasons why the degree variable is statistically significant, whereas the KBI employment variables are generally not. First, the statistically significant degree variable might be evidence that it is tacit knowledge/entrepreneurial ability, gained through university level education, which is the important component of graduates responsible for regional entrepreneurial activity, as opposed their employment in KBIs creating potential opportunities. Second, and with a significant spatial aspect, it might suggest that the propositions of the KSTE still hold, however employees in KBIs looking to appropriate a knowledge based opportunity prefer to start their firm in close proximity to where they live as opposed to where they work. Some occupational choice models (Kihlstrom and Laffont, 1979) suggest that people consider the return to entrepreneurship against wages from employment in their decision making process; accordingly, nascent entrepreneurs will look to maximise returns (i.e. minimise cost) from entrepreneurship when making this decision. As commuting can generally be considered a costly activity, in terms of both transportation costs and time, nascent entrepreneurs may look to start their firm closer to home to minimise commuting costs and maximise their return, thus increasing the local entrepreneurial activity amongst residential graduates. This is indicative as to how individual incentives, as opposed to broader structural factors creating opportunities, are vital in the entrepreneurial process. Again, Reynolds, Miller and Maki's (1995) argument is important here: "new firms are… started by people, not regional factors." However, the results may still arguably support the tenets of the KSTE, where employees may leave knowledge creating firms to start their own firms to appropriate an opportunity, but the comparison of the KBI variables in Chapter 7 and the degree variable of Chapter 8 may illuminate some aspects of the location decisions of these entrepreneurs.

The unrelated and related knowledge diversity indices provide some interesting insights in to the role of Jacobian externalities, particularly when analysed in conjunction with the general industrial diversity index. In particular, diversity in employment across knowledge sectors appears to encourage the realisation of Jacobian externalities that are conducive to the entrepreneurial process, whereas general industrial diversity does not. This is theoretically justified, as KBIs use knowledge as an input to a greater extent and, given that it has a greater propensity to spillover in comparison to other inputs (Arrow, 1962b), one might expect positive externalities occurring from spillovers across industries and firms to be more prominent in KBIs. This provides interesting insights into the nature of increasing returns accrued at a local level within the context of the 'New Economic Geography' (Krugman, 1991); specifically, the significant effect of diversity across knowledge sectors (KRE, KUE), compared to the insignificance of wider diversity across all sectors (HII), is perhaps indicative that Jacobian externalities are sector specific i.e. some sectors have a greater tendency to realise Jacobian externalities than others. This is particularly the case if the industries are located in close proximity, as evidenced by the consistently positive and significant estimated coefficients on the employment density variable across every model presented throughout Chapters 7 and 8. In terms of the debate as to whether MAR or Jacobian externalities are dominant in encouraging increasing returns to scale at a local level (Glaeser*, et al.*, 1992), the results suggest that it depends on context i.e. the type of industrial presence in a region.

The variables that appear to have the strongest and most significant explanatory power across the models can be interpreted as referring to concepts that are emphasised in occupational choice models, namely regarding the formation of expected future profits and the availability of capital, both financial and social. Concerning the former, the interpretation of the estimated coefficient on the regional unemployment variable (CLAIMRATE) fits within an occupational choice framework, where expected profit is weighted against the costs of entrepreneurship. Specifically, regional unemployment could signify poor demand and reduce expected future profits, offering a plausible explanation of the highly significant negative estimated coefficient observed across the models presented in Chapters 7 and 8. Concerning the latter, the positive estimated coefficient on the income variable (INCOME) could signify that the availability of financial capital is a significant determinant of entrepreneurial behaviour. Similarly, the negative coefficient of the OIR dummy variable (OIRDUM), signalling the possible absence of an adequate local entrepreneurial culture, could signify how certain forms of social capital are beneficial to the entrepreneurial process. Having a greater availability of financial and social capital might therefore reduce the cost of entrepreneurship and thus encourage entrepreneurial activity, which fits within the occupational choice framework. Moreover, issues relating to the estimation of future profits and availability of financial and social capital represent some of the practical issues faced by nascent entrepreneurs looking to appropriate perceived opportunities. All of these variables exhibit highly significant estimates; thus, the empirical results of Chapters 7 and 8 provide robust evidence that the individual thought processes forming an integral part of the occupational choice framework, discussed in Chapter 4 Section 4.3, are reflected in the behaviour of regional populations in a spatial context.

An important aim of this thesis was to assess whether the use of spatially autoregressive components in a linear regression analysis of entrepreneurship influenced the results in a significant manner; as indicated previously, this was motivated by the lack of spatial considerations in previous KSTE literature, with Bishop (2012) being a notable exception. However, the regression analysis of Chapters 7and 8 suggests that the inclusion of spatially autoregressive components, through either spatial lag or spatial error specifications, generally makes little substantive difference to the statistical inference associated with the estimated coefficients, at least in the context of regional entrepreneurship. This reaffirms the findings of Bishop (2012) who also found that utilising spatial specifications in a KSTE context made little difference to the statistical significance and inference of the estimates in the models. This is the case regardless of spatial specification or the form of spatial weights used. There are a few exceptions to this in the models presented in Chapters 7 and 8. First, the estimates of the non-spatial OLS linear regression models presented in Chapter 7 suggest that, in some cases, an increase in barriers to entrepreneurship would significantly detract from entrepreneurial behaviour in a region. However, the analogous spatial models of Chapter 7 suggest that the significance of the estimated coefficients of the barriers to entrepreneurship variable could be attributed to a spatial spillover, which is effectively controlled for with the use of spatial specifications. However, the models presented in Chapter 8, also using barriers to entrepreneurship as a control, found no such change with the implementation of spatial specifications, as the estimated coefficient of the barriers to entrepreneurship variable remain negative and highly significant throughout. It should be emphasised that the significance of the estimated coefficients of the barriers to entrepreneurship variable in the models of Chapter 7 was fairly weak and sensitive to the other explanatory variables; accordingly, it might be appropriate to suggest that the disappearance of significance observed in the spatial models of Chapter 7 can be attributed more to the general lack of explanatory power observed with the barriers to entrepreneurship variable in the KSTE models.

Second, the implementation of spatial specifications appears to strengthen the statistical significance and the magnitude of the estimated coefficients of the main knowledge variables, both the patent intensity variable (AVPAT/LNAVPAT) in the models in Chapter 7 and the concentration of university graduates variable (DEGREE) in Chapter 8. It is difficult to interpret what these changes represent in terms of specific spatial effects, beyond highlighting that in the context of entrepreneurship, spatial spillovers may detract from entrepreneurial behaviour as well as encourage it. For example, a nascent entrepreneur living in a rural region bordering a major urban area may encourage the start-up of a new firm in the urban area and outside the rural home region, in order to benefit from a larger labour market, and more custom. Here, the presence of a major urban area may detract from entrepreneurship in the neighbouring rural region by acting as a ‘vacuum’ that attracts entrepreneurs; controlling for these effects could perhaps explain the observed increase in some explanatory variables in the spatial models. For many of the other variables, particularly the income and ethnic diversity variables, the implementation of models with spatial components consistently reduced the magnitude of the estimated coefficients; despite not influencing the statistical significance of these variables, it nonetheless highlights the need for spatial econometric techniques to be utilised when dealing with spatial data of this nature.

As with any applied empirical investigation, it is useful to identify policy recommendations based on the results. However, this is complicated in the context of entrepreneurship due to the fact that “there is no entrepreneurship policy *per se*, only policy in an entrepreneurial economy” (Acs and Szerb, 2007). This entrepreneurial economy may be defined by three key features: a dynamic firm structure, the replacement of bureaucracies with markets and individual firms, and the varying nature of innovation in managerial and entrepreneurial settings. Thus, the ‘key question’ becomes “How can policy makers maintain - and ideally accelerate – the transition to a more entrepreneurial economy?” (Acs and Szerb, 2007).

In light of this, national and international organisations have developed a diverse range of policy frameworks in order to encourage the transition to a ‘more entrepreneurial economy’, implementing initiatives that seek to promote entrepreneurship and the growth of SMEs. In the UK these take the form of government funded ‘Start Up Loans’, which “provides start up support in the form of a repayable loan together with a business mentor for entrepreneurs across the UK” (Start Up Loans, 2014). Similarly, the privately funded ‘Start-Up Britain’ organised by the Centre for Entrepreneurs aims to highlight the “myriad of support that is available to those who wish to start or grow a business, galvanising support where we see a demand and by acting as a voice for small businesses to Government” (Centre for Entrepreneurs, 2014). These two initiatives illustrate the typical approaches of organisations looking to encourage entrepreneurship, with the former looking to ensure adequate access to finance and the latter looking to reduce the uncertainty faced by nascent entrepreneurs through providing information concerning support services. At a European level, the European Union (EU) has implemented the 'Entrepreneurship and Innovation Programme' (EIP), aimed at "fostering entrepreneurship culture and creating better framework conditions for SMEs operating in [the] EU" (EU, 2014). At a global level, both the OECD's 'Centre for Entrepreneurship' and the United Nation's Conference on Trade and Development (UNCTAD) have similar policies aimed at encouraging entrepreneurial activity globally (OECD, 2014; UNCTAD, 2014).

These initiatives focus on a variety of policies to encourage, promote, and support nascent entrepreneurs and SMEs, often under the umbrella of a broader 'enterprise' policy. However, equating entrepreneurship policy and SME policy, a common practice in the literature, is misguided, as SME policy is often geared towards existing organisations whereas entrepreneurship policy is geared towards individuals (Rigby and Ramlogan, 2013). It is, however, possible to identify entrepreneurship specific policy within the generalised enterprise policy framework. Acs and Szerb (2007) identify three general policy concerns that affect entrepreneurs specifically: easing of business formation, ensuring access to finance, and appropriate protection of intellectual property. Similarly, Rigby and Ramlogan (2013) believe that scope for entrepreneurship specific policy exists in the following areas: entrepreneurial orientation, goal seeking by entrepreneurs, the social contexts of entrepreneurship, broader links to labour, taxation and other policies, and skills development. Within these areas, rationales for public intervention through adequate policy are justified due to the lack of awareness, information problems, and access to finance issues faced by nascent entrepreneurs, as well as the need to align private and social interests in face of the externalities realisable from innovation and research (Rigby and Ramlogan, 2013). This last point is particularly pertinent in a KSTE context.

The empirical analysis presented in this thesis has important implications for entrepreneurship related policy in a number of areas, particularly those identified by Acs and Szerb (2007). The significant negative effect on entrepreneurship caused by the regulatory burden of the public sector suggests that more needs to be done to ease the process of business formation, possibly by reducing this regulatory and administrative burden. Similarly, the fact that entrepreneurial activity is generally higher in regions with higher median incomes may highlight the importance of adequate access to finance to the entrepreneurial process. These financial constraints might reflect inefficiencies in capital markets, in that some entrepreneurs are unable to source adequate finance through borrowing; this point has arguably been recognised by the government funded 'Start Up' loans initiative, who seek to provide start-up capital to nascent entrepreneurs. Alternatively, higher local incomes may also be interpreted as highlighting the importance of high local demand for goods and services in encouraging local entrepreneurship. One further interpretation of the empirical results of Chapter 7 is that IP rights are an important component of the entrepreneurial process. BIS (2011) has recognised that a "sound intellectual property framework is essential to protect incentives for entrepreneurship and innovation". A review of the UK IP framework, conducted in 2011, concluded that the UK IP framework needed updating in light of the issues posed by the digital economy (Hargreaves, 2011). However, any IP framework must strike a balance; legal protection that is too strong effectively promotes monopolies and hence limits social returns, whereas legal protection that is too weak can be easily circumvented and incentives to innovate might be insufficient (Acs and Szerb, 2007). The regression analysis presented in this thesis suggests that it is crucial that policy makers get policy initiatives right in these areas if they wish to encourage entrepreneurship.

Furthermore, the regression results of Chapter 8 shows that university graduates are particularly entrepreneurial. On this basis it could be argued that policy looking to promote entrepreneurship, particularly policy seeking to increase entrepreneurial orientation and highlight the plausibility of entrepreneurship as a future vocation, is likely to be more successful if targeted at university students. Moreover, universities provide a convenient forum within which to promote entrepreneurship as a potential future vocation, through the provision of publically or privately organised lectures, workshops, and open days in a centralised location. These initiatives provide an opportunity to effectively and efficiently disseminate information concerning the range of business support services that are available to nascent entrepreneurs.

However, some evidence presented by Rigby and Ramlogan (2013) suggests that the impact of policies that seek to 'promote cultural and behavioural change' through encouraging entrepreneurship amongst students has been fairly limited. This perhaps demonstrates the difficulty in encouraging entrepreneurship through policy initiatives. Research discussed in Chapter 6 shows that entrepreneurial culture is a persistent phenomenon that evolves slowly over time (Fritsch and Wyrwich, 2012) and Acs and Szerb (2007) reiterate this by highlighting that history matters to entrepreneurship. As such, "government policy aimed at promoting entrepreneurship or influencing the relevant factors cannot be effective in the short run, primarily because of cultural embedding" (Acs and Szerb, 2007: 119). Thus, understanding the slowly evolving, temporal nature of entrepreneurship is crucial when looking to design, implement, and assess policy looking to encourage entrepreneurial activity.

9.3 – Limitations and Recommendations for Future Research

As with any academic research, there are certain methodological issues and limitations that become apparent in the research process. Following from the suggestion of the short-run ineffectiveness of government policy concerning entrepreneurship, it might be argued that the clearest limitation that can be levelled at this research concerns its cross-sectional nature. That entrepreneurship is considered a persistent phenomenon that evolves slowly over time (Fritsch and Wyrwich, 2012), such that 'history matters' (Acs and Szerb, 2007), suggests an important temporal component to entrepreneurship. Furthermore, Kangasharju (2000) highlights how the interpretation of regression estimates can differ between cross-sectional and panel contexts. Addressing this limitation is fairly straightforward and remedied by repeating the analyses presented in this thesis with a series of spatial panel regression models; this will assess how the relationships between entrepreneurship and the explanatory variables utilised in this thesis evolve over time. At the commencement of the data collection process, only three years of data were available using the new ONS methodology, such that a temporal analysis was not possible. Of course, this issue remedies itself over time and the main recommendation for future research resulting from this thesis is to repeat this study in a spatial panel context.

Further insight into the KSTE could be achieved through the use of a dependent variable that is disaggregated by industrial classification i.e. firm births by industry by region. The insights of Chapter 7 suggest that some specific forms of regional knowledge, mainly denoted by regional employment in KIMS, have a significant impact on firm births, whereas other forms of knowledge, denoted by regional employment in other KBIs, do not. One of the reasons why employment in the other KBIs had a negligible impact on entrepreneurship in Chapter 7 could be the nature of the dependent variable; different regression results might be observed through utilising a sector specific dependent variable that could measure firm births in KBIs within a region, similar to the method use by Audretsch and Keilbach (2007). This makes the assumption that the KSTE is sector specific and modifies the *Endogenous Entrepreneurship Hypothesis* through suggesting that greater regional employment in KBIs results in greater entrepreneurial activity within KBIs. However, investigating the KSTE in such detail is limited by the availability of data, as the Business Demography statistics compiled by the ONS does not currently segregate firm birth data by region *and* by industry. However, as data collection techniques become more comprehensive over time, it is recommended that, should data become available, this might be a fruitful area for future research that would add to the insights of the KSTE.

A similar limitation of the approach utilised throughout this research concerns the limited relevant data available at an aggregated spatial level useful for approximating certain aspects of entrepreneurship. This was shown most clearly when seeking to quantify regional barriers to entrepreneurship, but was also applicable to other attempts at quantifying aspects of the entrepreneurial process. A large element of this is due to the fact that many aspects of entrepreneurship are idiosyncratic and unique to the individual. For example, Shane and Venkataraman (2000) highlight that entrepreneurship is an interaction between the opportunity and the *individual,* whilst Shane (2000) demonstrates that a key aspect of entrepreneurial behaviour involves *idiosyncratic* knowledge. Attempting to gain insight as to how these individual level aspects of entrepreneurship can influence entrepreneurial behaviour on a spatial level using econometric techniques is difficult, as aggregating data at a spatial level to reflect these characteristics was either impossible or resulted in variables that largely lost their meaning. Thus, these aspects of entrepreneurship require other research methods in order for more meaningful insight to be garnered. For example, in order to truly investigate how barriers to entrepreneurship affect how entrepreneurs appropriate opportunities, it would be useful to utilise qualitative research techniques on a case study basis. Naturally, whilst this may lose the spatial element that is emphasised throughout this thesis, it is nonetheless recommended that future research regarding barriers to entrepreneurship might benefit from an alternative methodological approach.

A further limitation to utilising spatial econometric techniques to investigate the determinants of entrepreneurship was the presence of heteroskedasticity across all of the models in Chapters 7 and 8; experimentation with different functional forms, the inclusion of various spatial components, in the form of a spatial lag or error term, and the use of different spatial weights failed to completely alleviate this issue. Of course, heteroskedasticity can be somewhat expected when analysing spatial data with spatial units that have boundaries arbitrarily defined for administrative purposes, as opposed to being more meaningful economic constructs. Fortunately, the practical implications of this heteroskedasticity, in terms of the reliability of the statistical inference associated with the estimated coefficients, were mitigated by the computation of analogous models using heteroskedasticity consistent standard errors.

These data and specification issues might be reflective of broader methodological issues in applying a deterministic causal framework to the study of entrepreneurship. Of course, as was discussed in Chapter 5, the use of econometric methods within an empirical epistemological paradigm is a well-accepted methodological approach within economic research. However, this deterministic causal framework makes several assumptions that are perhaps a little unsuited for modelling entrepreneurial behaviour. Throughout this thesis, a form of causality has been assumed where entrepreneurship is 'caused' by the presence of certain regional characteristics. Entrepreneurial opportunities were also assumed to exist exogenously as an objective reality, created through knowledge intensive activities and waiting to be discovered. Furthermore, econometric modelling approaches assume that primacy of rational expectations, namely that individuals use all of the information available to them in predictions of the value of future economic variables, such that errors are random and unpredictable (Hall, 1979; Mankiw, 2009). Again, utilising these assumptions and modelling techniques is well-accepted within economic methodology; however, the specification issues might reflect issues in utilising these assumptions and modelling techniques to the study of entrepreneurship in particular. These limitations can be framed within the deeper philosophical insights provided by Frank Knight and the Austrian School of thought, specifically asking 'to what extent can entrepreneurial decision making be '*rational*' and '*deterministic*' in the face of true uncertainty?' As Knight (1921) argues, the nature of the 'true uncertainty' that characterises entrepreneurship implies that there is effectively no information available from which to make informed decisions, due to the uniqueness of entrepreneurial opportunities. Accordingly, the assumption of rational expectations and that errors are random is perhaps a little misguided in this context. Furthermore, it could be argued that due to the nature of 'true uncertainty', entrepreneurship can be considered as a reflection of free will in human decision making, which by definition is not deterministic. The causal relationships and assumptions characterising regression models deal with individuals acting in a deterministic manner according to the constraints or conditions that they face. The relevance of these insights can be illustrated further by similarly considering the Schumpeterian (1934) approach, which posits that entrepreneurs *change* constraints and hence do not make decisions within a deterministic framework, such as the one posited in econometric analysis. These issues cannot be addressed by the research presented here, but the specification issues present in the models presented might suggest a greater need for further study of entrepreneurship within a broader philosophical framework that considers the true nature of uncertainty, free will, and bounded rationality (Simon, 1990).

9.4 – Concluding Remarks

This thesis has sought to provide a comprehensive spatial analysis of entrepreneurship across GB from 2008-2010. Through utilising spatial econometric methods, using newly available data on firm births and a range of original variables, the models provided extensive insight into the determinants of entrepreneurship. Specifically, a range of variables relating to explicit and tacit knowledge, intellectual property, income, unemployment, experience, and local entrepreneurial culture were found to have significant effects on the spatial variation of entrepreneurship. The complex nature of entrepreneurship was apparent throughout the research process and revealed itself in a number of ways. From the review of relevant literature, it became apparent why there is a lack of an accepted definition of entrepreneurship in economic theory (Casson, 2003), as entrepreneurship can be considered a complex allegorical concept that derives its meaning from a variety of features central to economic reality. However, the empirical manifestation of entrepreneurship, the birth of a new firm, provides an operational definition of entrepreneurship that embodies many of these features and was particularly useful to the research objectives of this thesis. Furthermore, there were significant difficulties in gathering adequate data and applying the appropriate spatial econometric techniques that had to be overcome. Once overcome, what results is a comprehensive, applied empirical investigation that contributes significantly to understanding the nature of entrepreneurship in the KBE.

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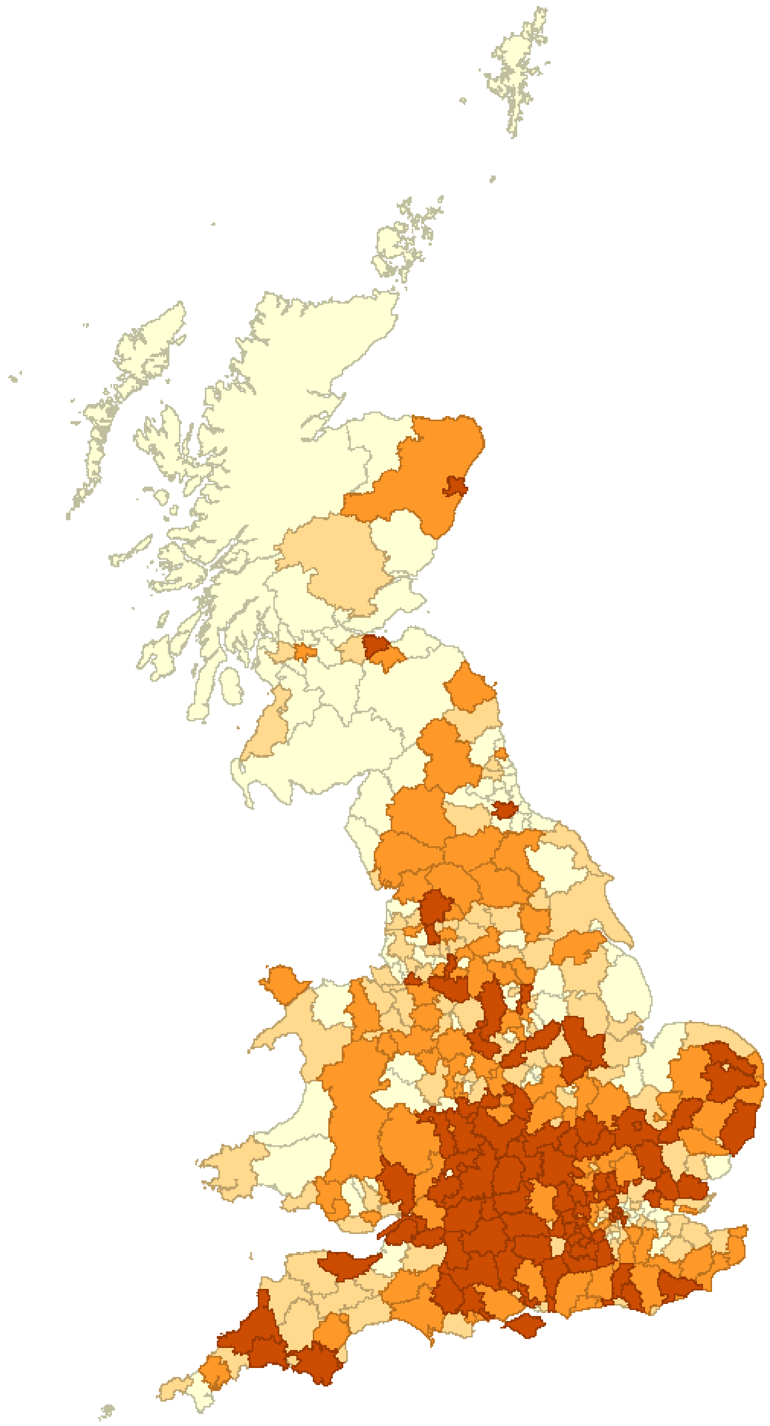
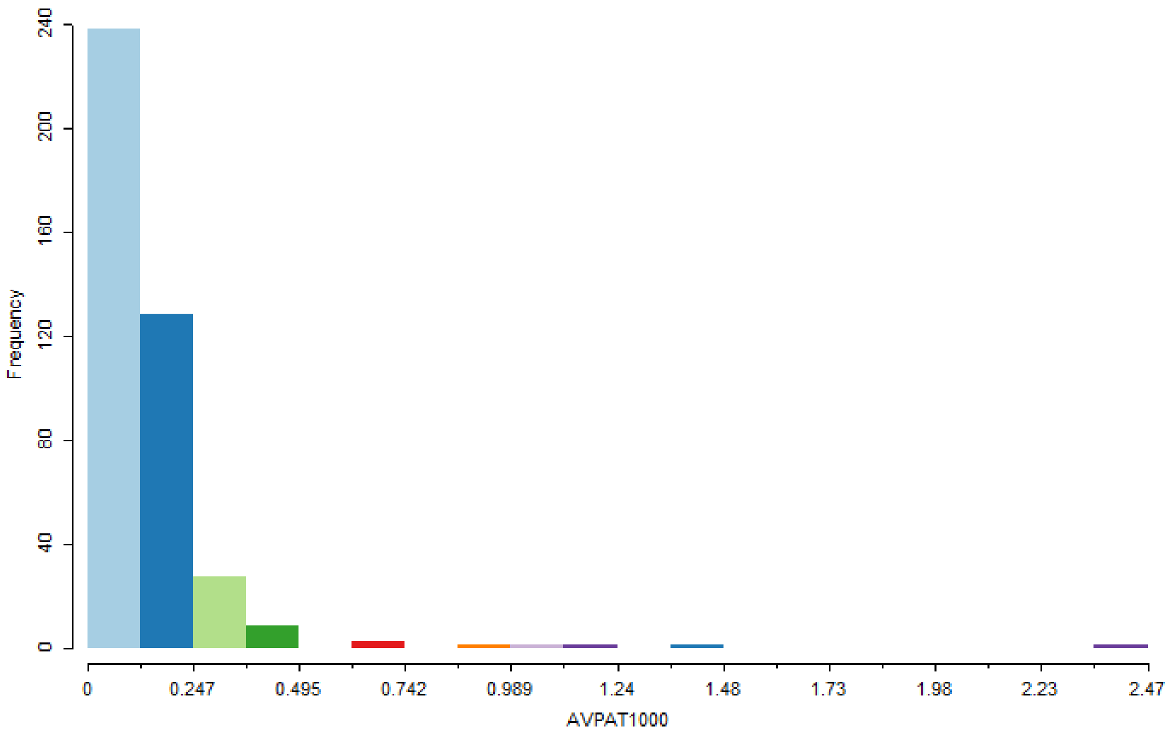
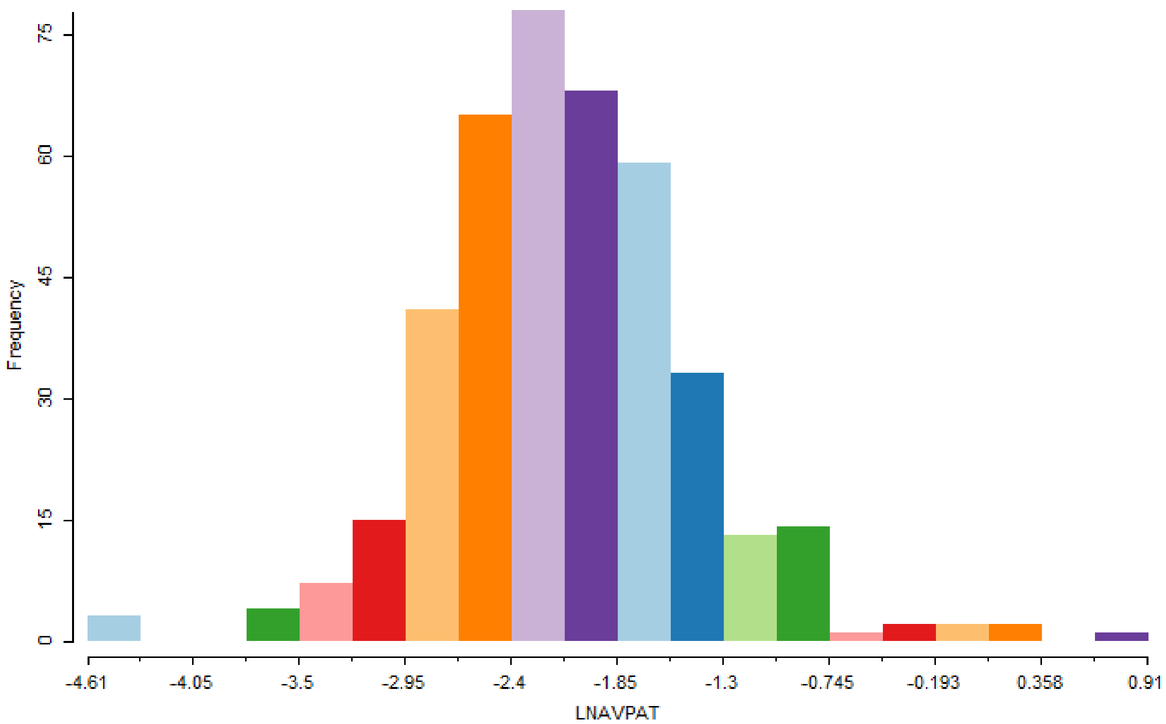
Appendix

A1. Quartile map showing the spatial distribution of regional patent intensities, measured by the number of patents registered within a region per 1000 of the population aged 16-64 (AVPAT1000). Darker regions signify more 'patent intense' regions, whereas the lighter regions signal the opposite.



A2. Histograms showing the distribution of AVPAT1000 (top) and the logarithmic transformation of AVPAT1000 (LNAVPAT) (bottom)





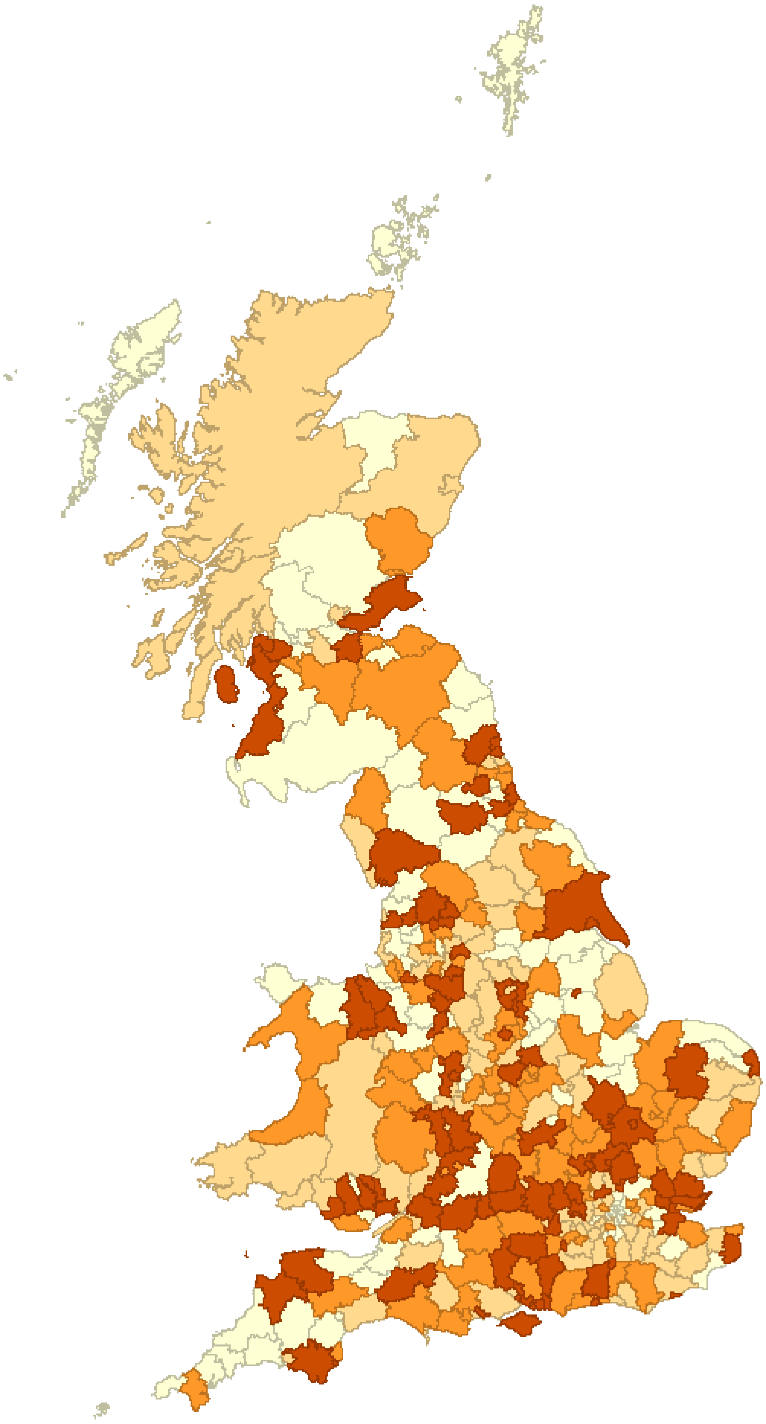
A3. Composition of KIS sector as defined by Eurostat using NACE divisions

The following sectors are defined as **knowledge-intensive services**, abbreviated as **KIS** (NACE divisions between brackets):

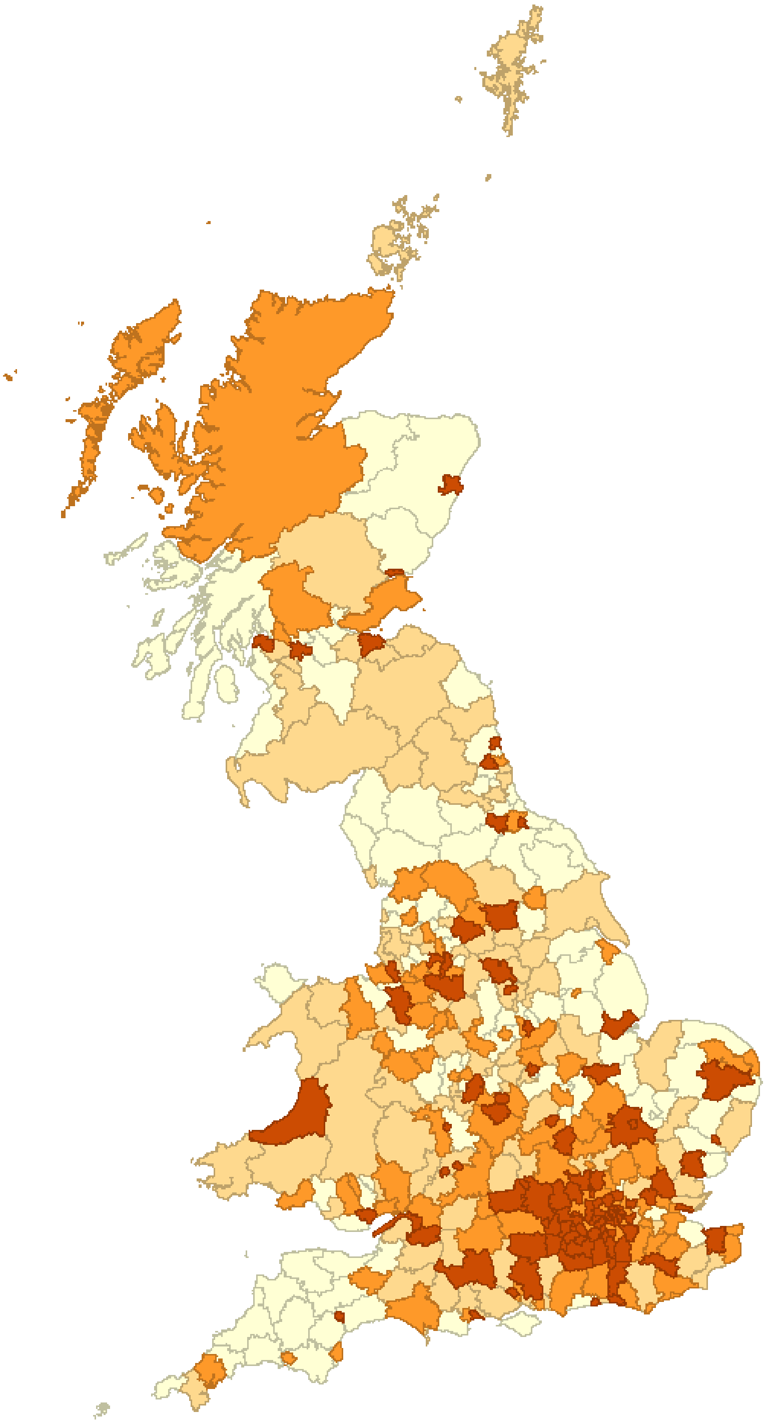
- Knowledge-Intensive High-tech Services (KIHTS):
  - Post and Telecommunications (64);
  - Computer and related activities (72);
  - Research and development (73);
- Knowledge-Intensive Market Services (KIMS) (excluding financial intermediation and high-tech services):
  - Water transport (61);
  - Air transport (62);
  - Real estate activities (70);
  - Renting of machinery and equipment without operator, and of personal and household goods (71);
  - Other business activities (74);
- Knowledge-Intensive Financial Services (KIFS):
  - Financial intermediation, except insurance and pension funding (65);
  - Insurance and pension funding, except compulsory social security (66);
  - Activities auxiliary to financial intermediation (67);
- Other Knowledge-Intensive Services (OKIS):
  - Education (80);
  - Health and social work (85);
  - Recreational, cultural and sporting activities (92).

Source: Eurostat 2014

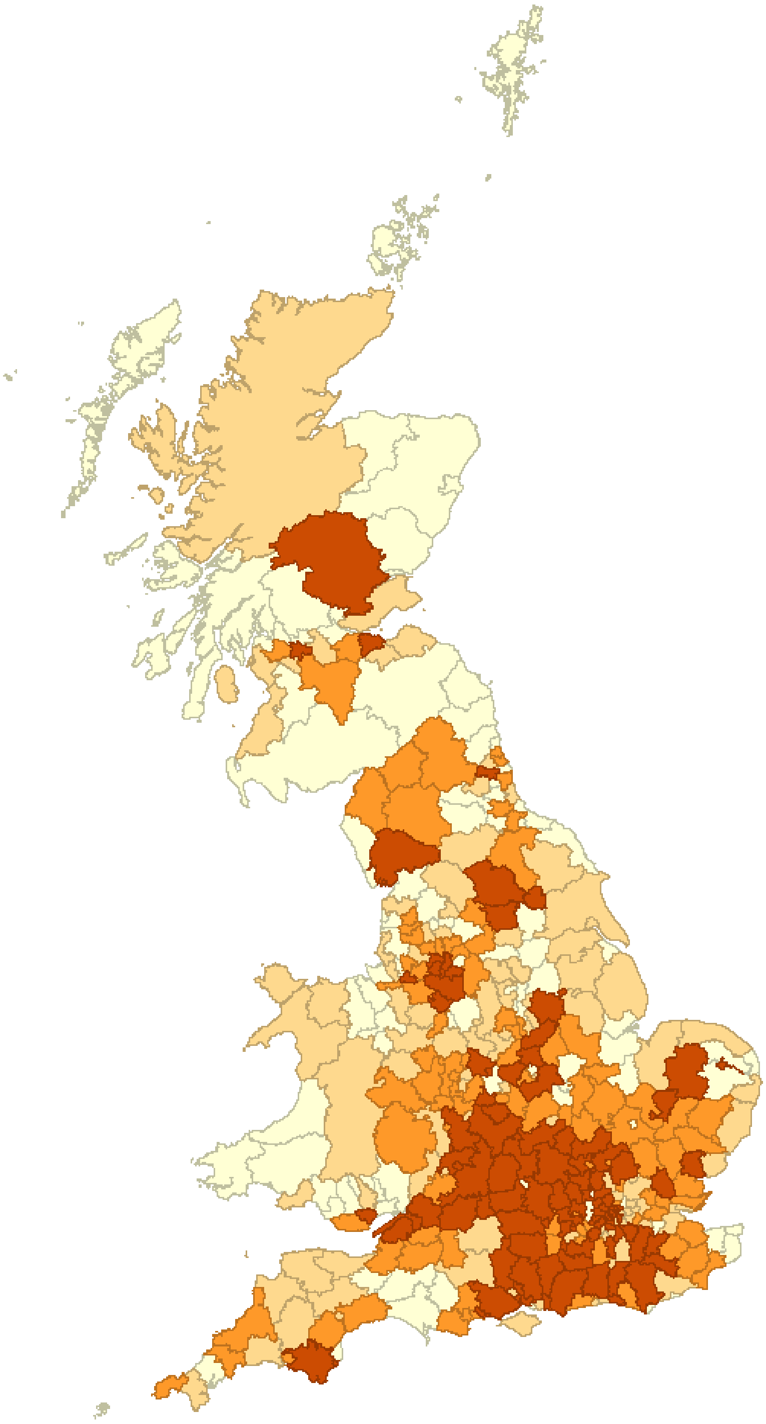
A4. Quartile maps showing spatial distribution of employment in HTM sectors across GB 2008-2010. Darker regions indicate greater employment in these sectors, whereas lighter regions indicate lesser employment.



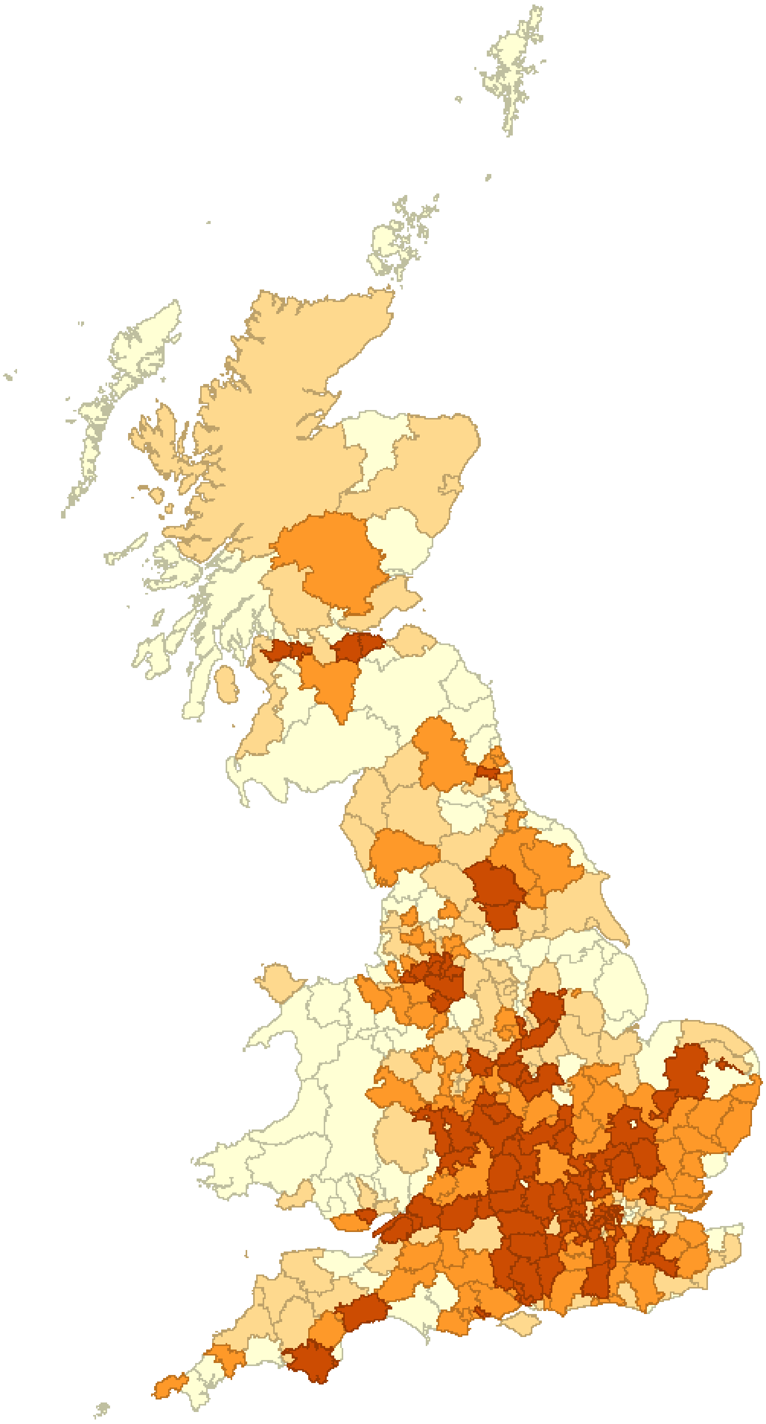
A5. Quartile map showing spatial distribution of employment in KIS employment across GB 2008-2010. Darker regions indicate greater employment in these sectors, whereas lighter regions indicate lesser employment



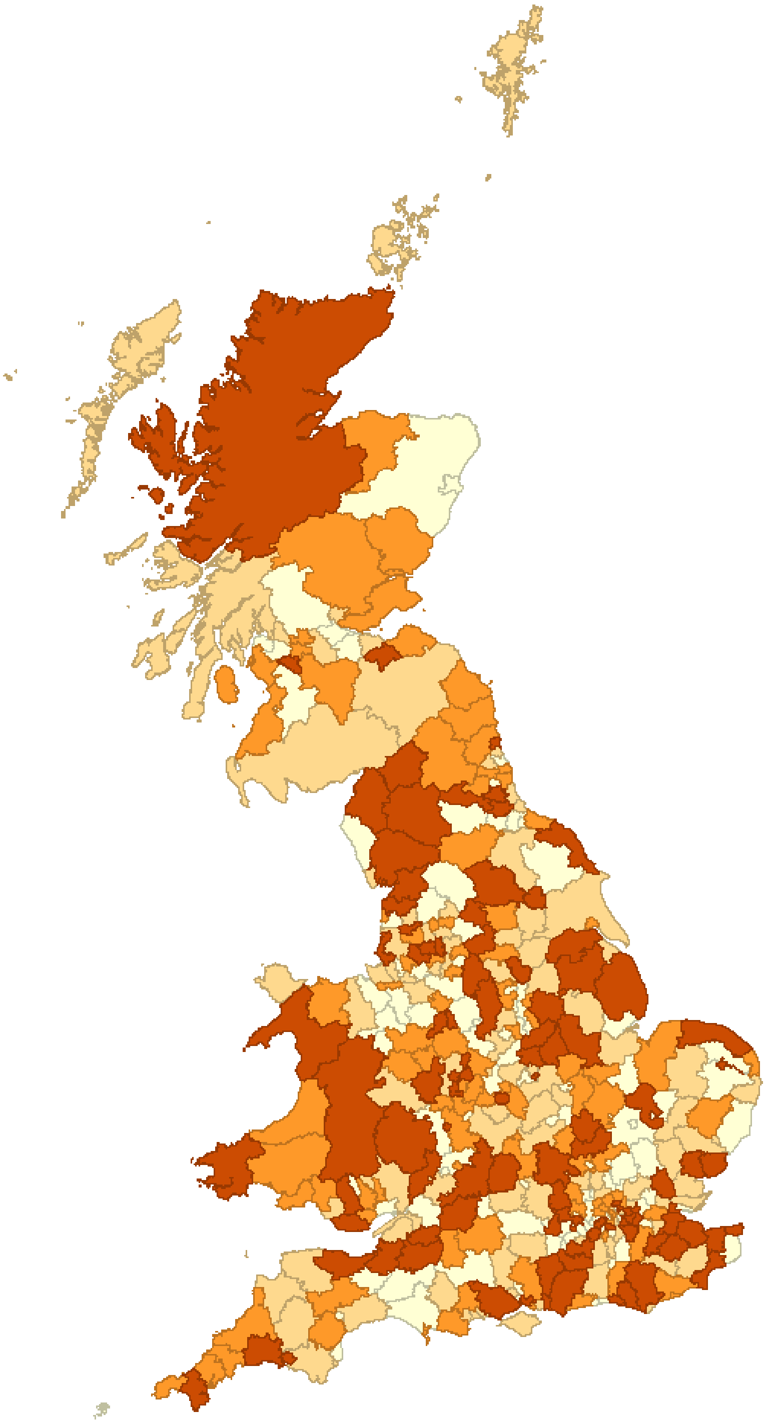
A6. Quartile map showing the spatial distribution of sectoral diversity in employment across KBI sectors in GB 2008-2010, measured using TKE. Darker regions show greater sectoral diversity, whereas lighter regions indicate lesser diversity in employment across KBI sectors.



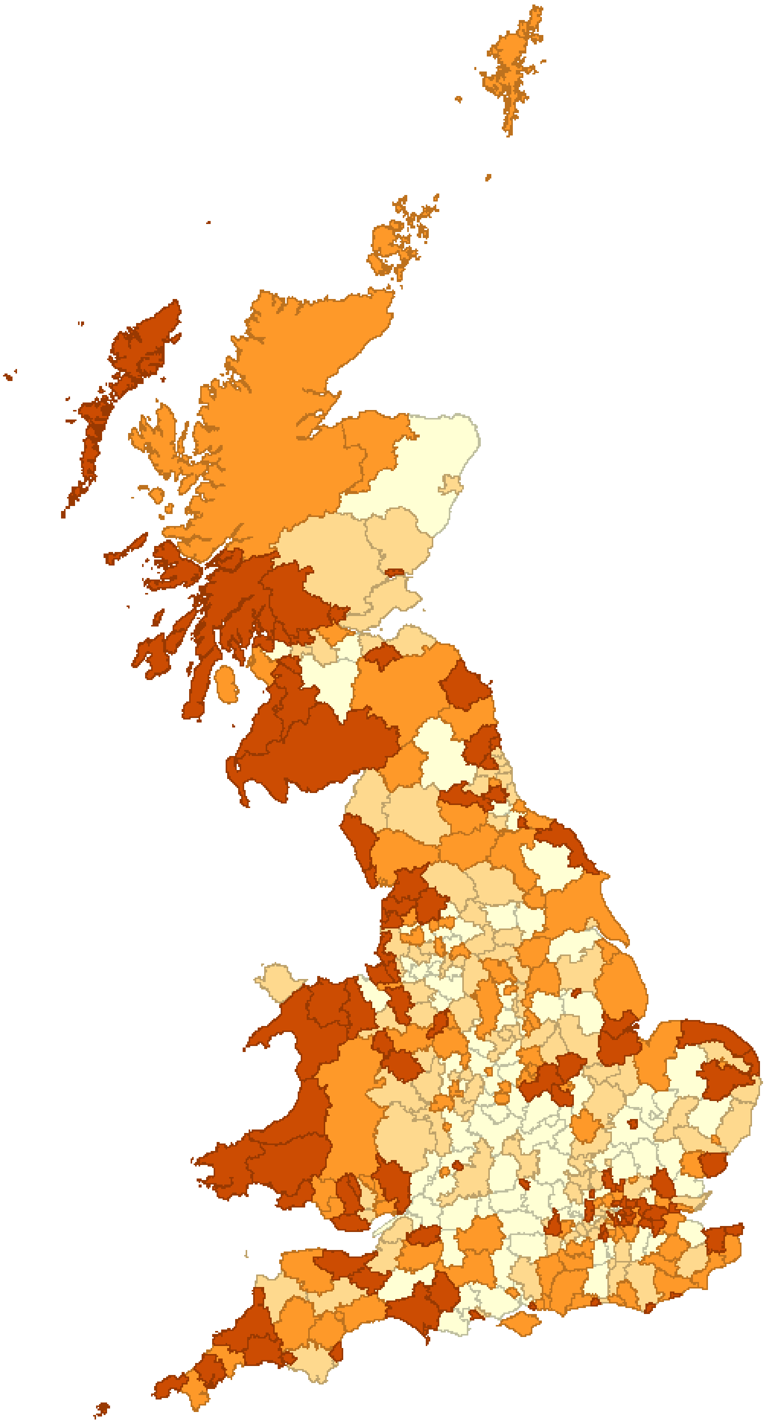
A7. Quartile map showing the spatial distribution of unrelated sectoral diversity in employment across KBI sectors in GB 2008-2010, measured using KUE. Darker regions show greater unrelated sectoral diversity, whereas lighter regions indicate lesser unrelated diversity in employment across KBI sectors.



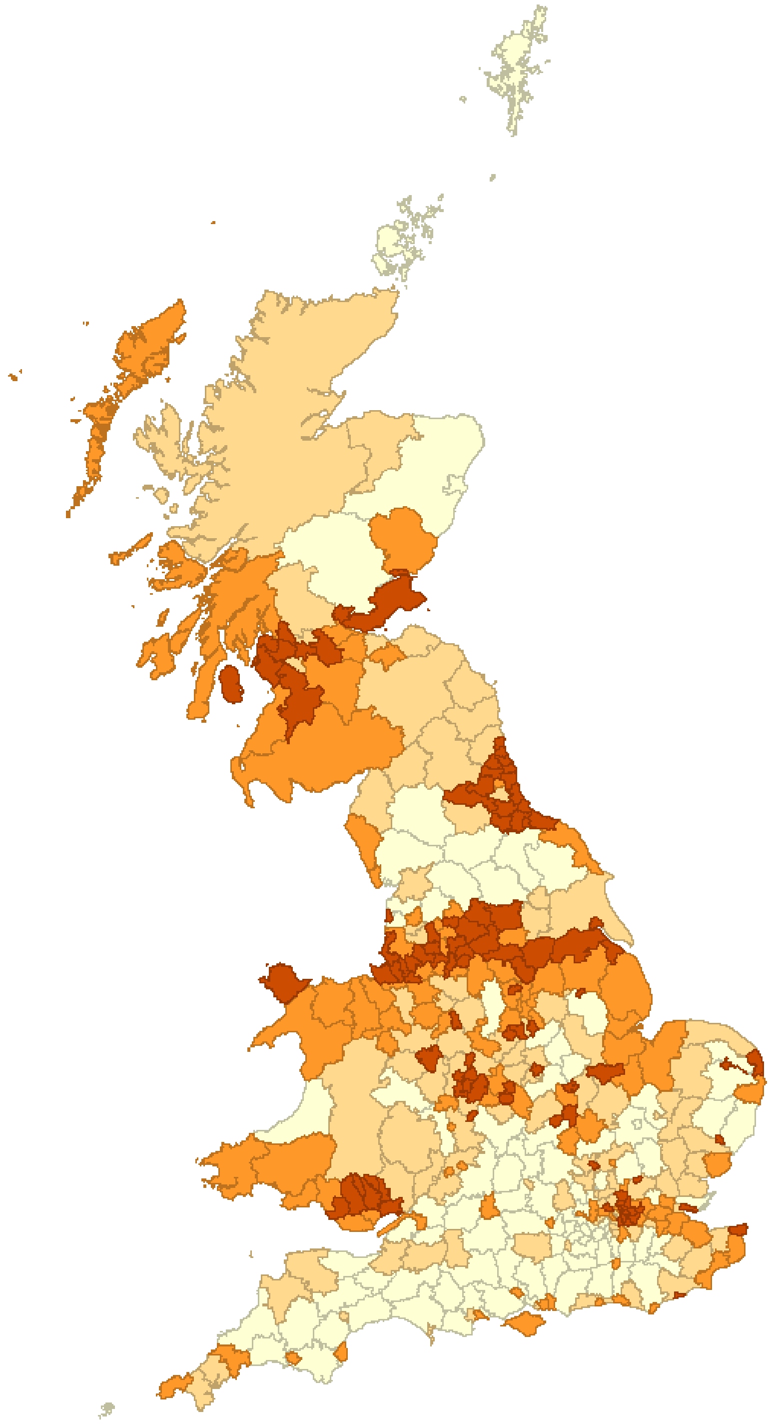
A8. Quartile map showing the spatial distribution of related sectoral diversity in employment across KBI sectors in GB 2008-2010, measured using KRE. Darker regions show greater related sectoral diversity, whereas lighter regions indicate lesser related diversity in employment across KBI sectors.



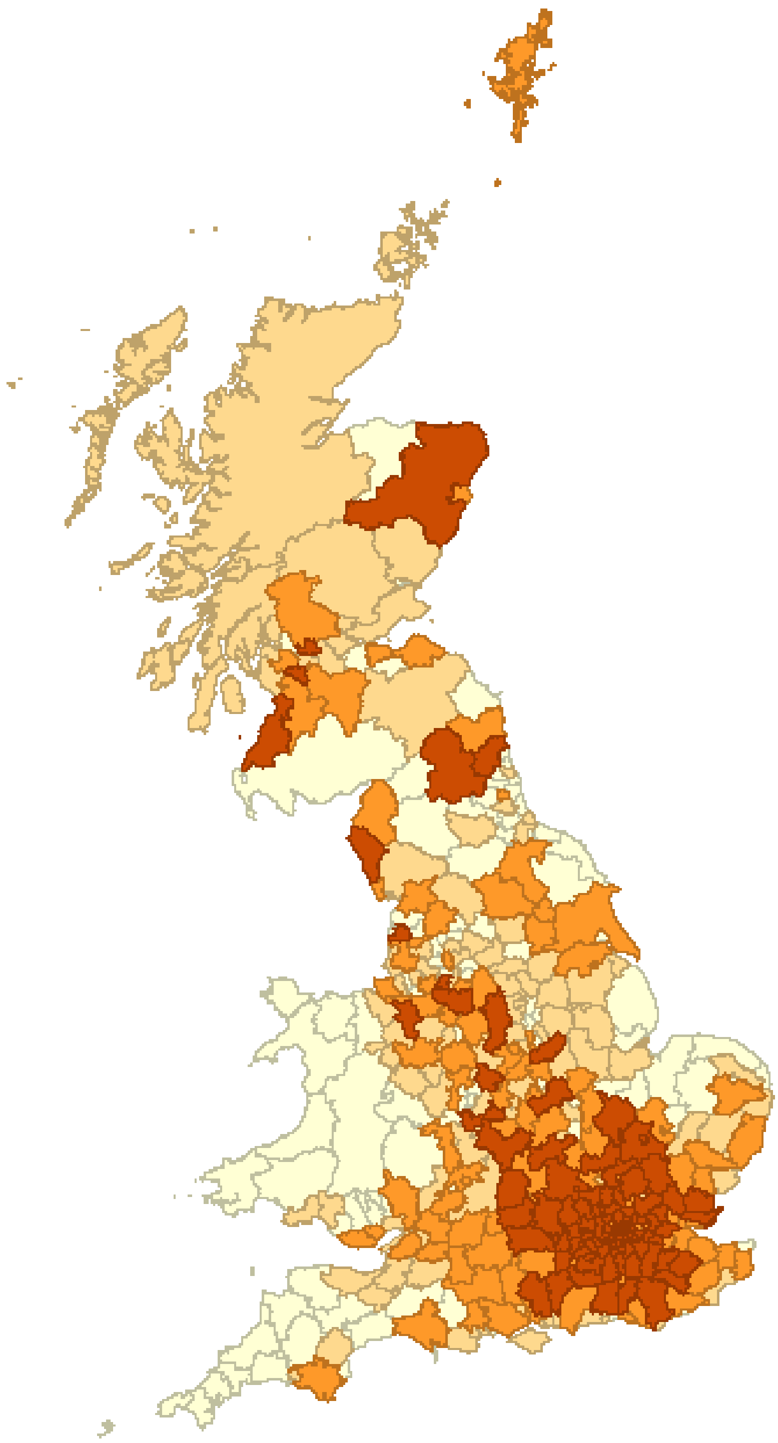
A9. Quartile map showing the spatial distribution of sectoral diversity in employment across all SIC 2-digit industrial sectors in GB 2008-2010, measured using HHI. Lighter regions show greater sectoral diversity, whereas darker regions indicate lesser diversity in employment across KBI sectors.



A10. Quartile map showing regional claimant count rates across GB 2008-2010. The darker shaded areas signify regions with higher claimant count rates, whereas the lighter shaded areas exhibit lower claimant count rates.



A11. Quartile map showing the spatial distributions of regional median incomes across GB 2008-2010, measured through the median income of the resident population of each region. Darker areas indicate regions with greater median incomes, whereas lighter areas signify regions with lower median incomes.



A12. Data sources for all of the explanatory variables used in the regression analysis of Chapter 7

Variable	Source
AVPAT	UK Intellectual Property Office
LNAVPAT	UK Intellectual Property Office
UNIDUM	Dummy variable constructed using postcodes from main addresses of each university in GB
HTM	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
KIFS	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
KIHTS	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
KIMS	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
OKIS	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
KIS	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
KRE	Indices constructed using Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
KUE	Indices constructed using Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
HHI	Indices constructed using Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
EMPDENS	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
PSEMP	Labour market statistics compiled by the Office of National Statistics (NOMIS) Business Register and Employment Survey
CLAIMRATE	Labour market statistics compiled by the Office of National Statistics (NOMIS) Claimant Count Data
INCOME	Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Survey of Hours and Earnings
OIR	Indicator variable constructed from Birch, MacKinnon and Cumbers (2010). NUTS Level 2 OIRs. The NUTS level 2 regions were cross referenced with their LAD counterparts using GeoConvert software available through EDINA (http://edina.ac.uk)
LONDUM	Dummy variable indicating the City of London LAD

A13. Lagrange Multiplier spatial diagnostic tests for OLS models M1-M5 in Chapter 7 using QCO1, QCO2, 4NN, and 8NN spatial weights

Spatial Weights	LM Test	M1	M2	M3	M4	M5
QCO1	LM Lag	40.420 (0.00)	35.365 (0.00)	38.835 (0.00)	36.007 (0.00)	39.368 (0.00)
	Robust LM Lag	13.701 (0.00021)	10.609 (0.00113)	10.199 (0.00141)	11.038 (0.00089)	10.579 (0.00114)
	LM Error	51.927 (0.00)	50.792 (0.00)	61.604 (0.00)	50.664 (0.00)	61.294 (0.00)
	Robust LM Error	25.208 (0.00)	26.037 (0.00)	32.968 (0.00)	25.696 (0.00)	32.504 (0.00)
QCO2	LM Lag	28.183 (0.00)	24.066 (0.00)	26.472 (0.00)	25.065 (0.00)	27.394 (0.00)
	Robust LM Lag	14.122 (0.0002)	11.401 (0.0007)	12.191 (0.0005)	11.747 (0.0006)	12.489 (0.0004)
	LM Error	35.219 (0.00)	33.394 (0.00)	37.526 (0.00)	35.586 (0.00)	39.645 (0.00)
	Robust LM Error	21.158 (0.00)	20.728 (0.00)	23.245 (0.00)	22.268 (0.00)	24.739 (0.00)
4NN	LM Lag	70.547 (0.00)	70.327 (0.00)	71.872 (0.00)	71.387 (0.00)	72.681 (0.00)
	Robust LM Lag	21.192 (0.00)	22.728 (0.00)	20.156 (0.00)	22.552 (0.00)	19.868 (0.00)
	LM Error	59.927 (0.00)	56.930 (0.00)	65.584 (0.00)	58.719 (0.00)	67.397 (0.00)
	Robust LM Error	10.572 (0.0011)	9.331 (0.0023)	13.868 (0.0002)	9.884 (0.0017)	14.583 (0.00)
8NN	LM Lag	89.342 (0.00)	89.050 (0.00)	89.406 (0.00)	90.923 (0.00)	91.036 (0.00)
	Robust LM Lag	38.341 (0.00)	40.569 (0.00)	35.101 (0.00)	40.937 (0.00)	35.266 (0.00)
	LM Error	76.375 (0.00)	70.900 (0.00)	87.691 (0.00)	73.688 (0.00)	90.771 (0.00)
	Robust LM Error	25.374 (0.00)	22.418 (0.00)	33.386 (0.00)	23.702 (0.00)	35.000 (0.00)

A14. Two stage least squares estimation of spatial models SM1-SM10 using QCO1 and QCO2 spatial weights with KP HET heteroskedasticity consistent standard errors. Dependent variable: LNFB1000. No. of observations = 408.

	SM1	SM2	SM3	SM4	SM5
Constant	0.347 (0.172)	0.580 (0.023)**	0.589 (0.012)**	0.707 (0.00)***	0.717 (0.00)***
Regional Patent Intensity (AVPAT)	0.186 (0.015)**				
Ln (Regional Patent Intensity) (LNAVPAT)		0.051 (0.00)***	0.053 (0.00)***	0.050 (0.00)***	0.053 (0.00)***
University Dummy (UNIDUM)	-0.072 (0.00)***	-0.071 (0.00)***	-0.063 (0.002)***	-0.070 (0.00)***	-0.062 (0.002)***
High Technology Manufacturing (HTM)	0.129 (0.829)	0.045 (0.939)	0.209 (0.716)	0.076 (0.899)	0.177 (0.767)
Knowledge Intensive Financial Services (KIFS)	0.188 (0.564)	0.142 (0.657)		0.174 (0.591)	
Knowledge Intensive High-tech Services (KIHTS)	-0.072 (0.855)	-0.023 (0.951)		-0.020 (0.958)	
Knowledge Intensive Market Services (KIMS)	1.308 (0.00)***	1.170 (0.00)***		1.196 (0.00)***	
Other Knowledge Intensive Services (OKIS)	0.039 (0.881)	-0.013 (0.961)		0.023 (0.928)	
Knowledge Intensive Services (KIS)			0.216 (0.174)		0.244 (0.117)
Related Knowledge Entropy (KRE)	0.195 (0.024)**	0.176 (0.041)**	0.081 (0.284)	0.167 (0.054)**	0.074 (0.335)
Unrelated Knowledge Entropy (KUE)	0.238 (0.002)***	0.216 (0.006)***	0.264 (0.00)***	0.178 (0.006)***	0.225 (0.00)***
Broad Industrial Diversity Index (HHI)	1.037 (0.433)	1.044 (0.429)	-1.023 (0.458)		
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-0.410 (0.217)	-0.340 (0.296)	-0.437 (0.182)	-0.245 (0.424)	0.343 (0.260)
Claimant Rate (CLAIMRATE)	-0.059 (0.00)***	-0.058 (0.00)***	-0.059 (0.00)***	-0.059 (0.00)***	0.061 (0.00)***
Median Incomes (INCOME)	0.00136 (0.00)***	0.0013 (0.00)***	0.0013 (0.00)***	0.0013 (0.00)***	0.0014 (0.00)***
Old Industrial Region Dummy (OIR)	-0.085 (0.001)***	-0.087 (0.00)***	-0.094 (0.00)***	-0.089 (0.00)***	-0.096 (0.00)***
City of London Dummy (LONDUM)	-0.976 (0.027)**	-0.945 (0.053)*	-1.218 (0.009)***	-0.930 (0.049)**	1.198 (0.008)***
Lambda	0.552 (0.00)***	0.536 (0.00)***	0.564 (0.00)***	0.529 (0.00)***	0.556 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using KP HET standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.800	0.804	0.795	0.804	0.794

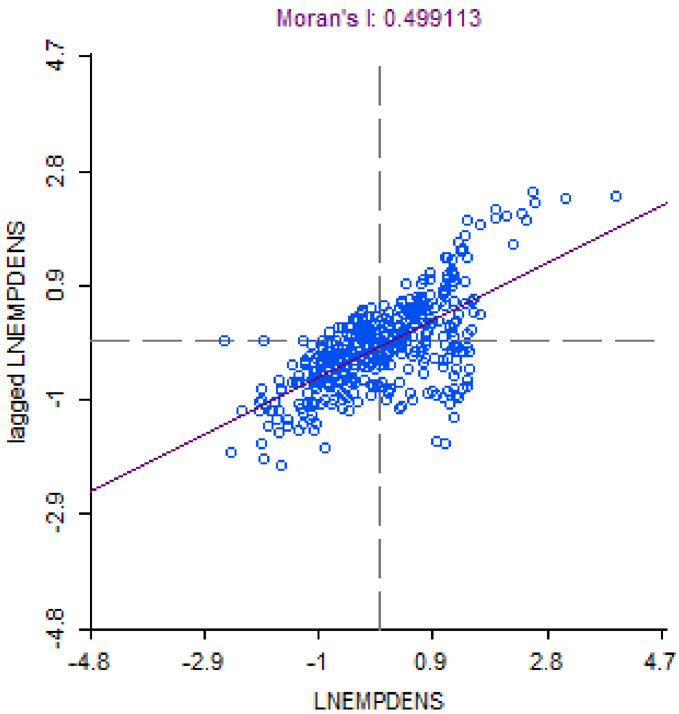
	SM6	SM7	SM8	SM9	SM10
Constant	0.430 (0.087)*	0.636 (0.011)**	0.620 (0.009)***	0.682 (0.001)***	0.657 (0.00)***
Regional Patent Intensity (AVPAT)	0.127 (0.098)*				
Ln (Regional Patent Intensity) (LNAVPAT)		0.046 (0.001)***	0.046 (0.003)***	0.046 (0.001)***	0.046 (0.003)***
University Dummy (UNIDUM)	-0.094 (0.00)***	-0.0911 (0.00)***	0.083 (0.00)***	-0.091 (0.00)***	-0.083 (0.00)***
High Technology Manufacturing (HTM)	0.460 (0.436)	0.318 (0.583)	-0.031 (0.958)	0.322 (0.583)	-0.027 (0.963)
Knowledge Intensive Financial Services (KIFS)	0.325 (0.360)	0.297 (0.387)		0.309 (0.369)	
Knowledge Intensive High-tech Services (KIHTS)	-0.205 (0.602)	-0.183 (0.638)		-0.186 (0.632)	
Knowledge Intensive Market Services (KIMS)	1.443 (0.00)***	1.320 (0.00)***		1.321 (0.00)***	
Other Knowledge Intensive Services (OKIS)	0.004 (0.989)	0.071 (0.002)***		-0.048 (0.870)	
Knowledge Intensive Services (KIS)			0.250 (0.163)		0.255 (0.157)
Related Knowledge Entropy (KRE)	0.294 (0.00)***	0.277 (0.001)***	0.163 (0.028)**	0.272 (0.001)***	0.161 (0.031)**
Unrelated Knowledge Entropy (KUE)	0.207 (0.01)**	0.185 (0.020)**	0.246 (0.00)***	0.173 (0.009)***	0.235 (0.00)***
Broad Industrial Diversity Index (HHI)	0.264 (0.838)	0.360 (0.780)	0.267 (0.847)		
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-0.515 (0.125)	-0.440 (0.177)	-0.596 (0.074)*	-0.408 (0.189)	-0.569 (0.069)*
Claimant Rate (CLAIMRATE)	-0.070 (0.00)***	-0.067 (0.00)***	0.070 (0.00)***	-0.068 (0.00)***	-0.070 (0.00)***
Median Incomes (INCOME)	0.0012 (0.00)***	0.0012 (0.00)***	0.0013 (0.00)***	0.0012 (0.00)***	0.0013 (0.00)***
Old Industrial Region Dummy (OIR)	-0.068 (0.004)***	-0.071 (0.002)***	-0.075 (0.002)***	-0.071 (0.002)***	-0.075 (0.001)***
City of London Dummy (LONDUM)	-1.268 (0.003)***	-1.232 (0.004)***	-1.455 (0.001)***	-1.209 (0.004)***	-1.433 (0.00)***
Lambda	0.629 (0.00)***	0.623 (0.00)***	0.638 (0.00)***	0.628 (0.00)***	0.643 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using KP HET standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.800	0.803	0.793	0.803	0.793

A15. Two stage least squares estimation of spatial models SM11-SM20 using 4NN and 8NN spatial weights with HAC heteroskedasticity consistent standard errors. Dependent variable: LNFB1000. No. of observations = 408.

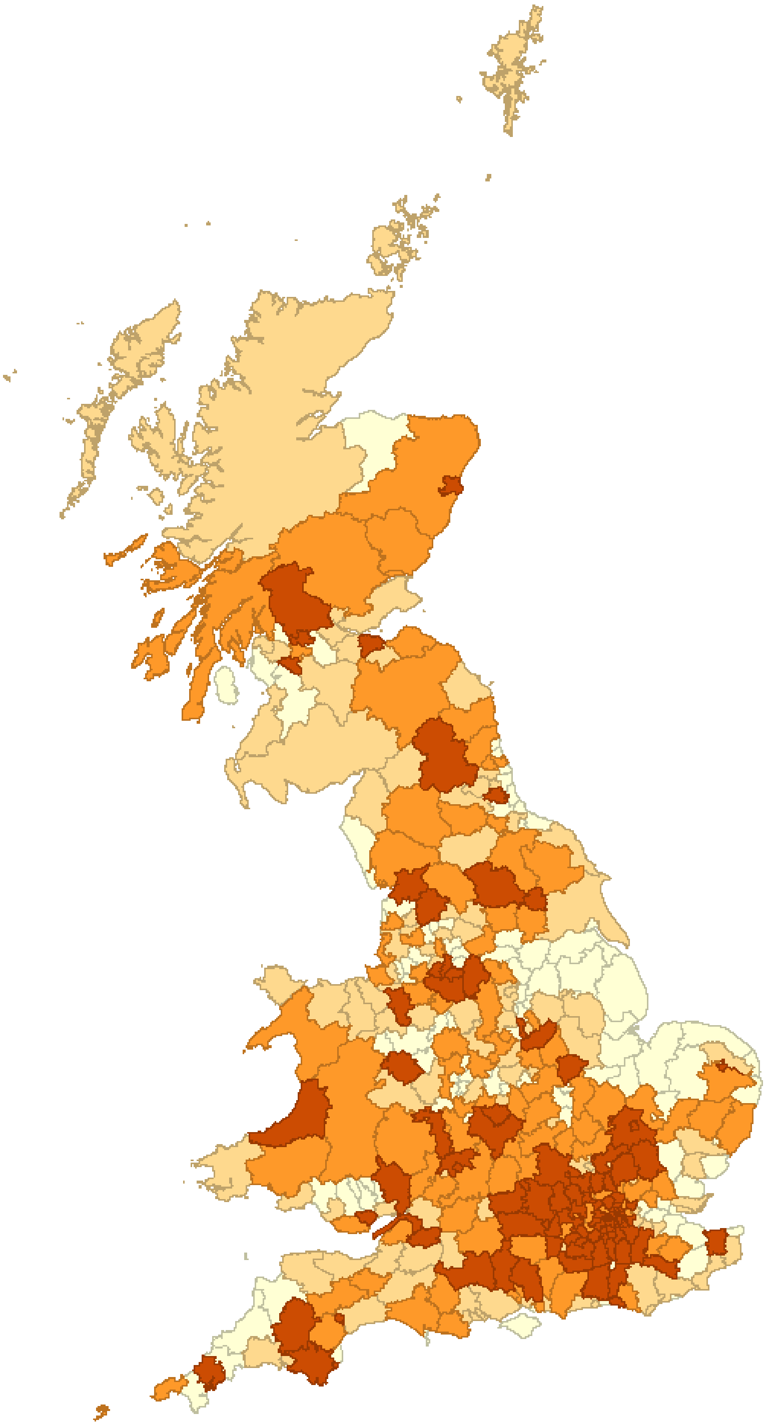
	SM11	SM12	SM13	SM14	SM15
Constant	0.039 (0.869)	0.244 (0.294)	0.249 (0.246)	0.322 (0.098)*	0.332 (0.052)
Regional Patent Intensity (AVPAT)	0.139 (0.098)*				
Ln (Regional Patent Intensity) (LNAVPAT)		0.046 (0.00)***	0.046 (0.002)***	0.046 (0.00)***	0.045 (0.002)***
University Dummy (UNIDUM)	-0.075 (0.00)***	-0.073 (0.00)***	-0.068 (0.00)***	-0.073 (0.00)***	-0.068 (0.00)***
High Technology Manufacturing (HTM)	0.405 (0.529)	0.264 (0.676)	-0.027 (0.967)	0.288 (0.657)	-0.0016 (0.998)
Knowledge Intensive Financial Services (KIFS)	0.285 (0.350)	0.248 (0.404)		0.263) (0.381)	
Knowledge Intensive High-tech Services (KIHTS)	-0.537 (0.184)	-0521 (0.201)		-0.512 (0.206)	
Knowledge Intensive Market Services (KIMS)	1.155 (0.00)***	1.025 (0.00)***		1.043 (0.00)***	
Other Knowledge Intensive Services (OKIS)	-0.093 (0.737)	-0.160 (0.573)		-0.133 (0.638)	
Knowledge Intensive Services (KIS)			0.087 (0.632)		0.107 (0.556)
Related Knowledge Entropy (KRE)	0.230 (0.009)***	0.209 (0.018)**	0.120 (0.114)	0.204 (0.022)**	0.115 (0.134)
Unrelated Knowledge Entropy (KUE)	0.196 (0.011)**	0.174 (0.021)**	0.220 (0.00)***	0.150 (0.019)**	0.194 (0.00)***
Broad Industrial Diversity Index (HHI)	0.551 (0.675)	0.646 (0.616)	0.628 (0.638)		
Employment Density (EMPDENS)	0.00001 (0.012)**	0.00001 (0.005)***	0.00002 (0.00)***	0.00002 (0.004)***	0.00002 (0.00)***
Public Sector Employment (PSEMP)	-0.324 (0.338)	-0.244 (0.447)	-0.417 (0.208)	-0.191 (0.547)	-0.360 (0.270)
Claimant Rate (CLAIMRATE)	-0.057 (0.00)***	-0.054 (0.00)***	-0.055 (0.00)***	-0.055 (0.002)***	-0.056 (0.00)***
Median Incomes (INCOME)	0.0011 (0.00)***	0.0011 (0.00)***	0.0012 (0.00)***	0.0011 (0.00)***	0.0012 (0.00)***
Old Industrial Region Dummy (OIR)	-0.029 (0.213)	-0.021 (0.180)	-0.043 (0.075)*	-0.033 (0.154)	-0.0044 (0.060)*
City of London Dummy (LONDUM)	0.683 (0.254)	0.700 (0.265)	0.366 (0.545)	0.705 (0.253)	0.376 (0.528)
W_LAG LNFB100	(0.317) (0.00)***	0.313 (0.00)***	0.295 (0.00)***	0.312 (0.00)***	0.295 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using HAC standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.836	0.839	0.831	0.839	0.831

	SM16	SM17	SM18	SM19	SM20
Constant	0.182 (0.420)	0.393 (0.074)*	0.362 (0.070)*	0.417 (0.029)**	0.390 (0.018)**
Regional Patent Intensity (AVPAT)	0.152 (0.073)*				
Ln (Regional Patent Intensity) (LNAVPAT)		0.048 (0.00)***	0.047 (0.001)***	0.048 (0.00)***	0.047 (0.00)***
University Dummy (UNIDUM)	-0.074 (0.00)***	-0.072 (0.00)***	-0.067 (0.001)***	-0.072 (0.00)***	-0.067 (0.001)***
High Technology Manufacturing (HTM)	0.289 (0.637)	0.149 (0.805)	-0.150 (0.813)	0.156 (0.799)	-0.140 (0.828)
Knowledge Intensive Financial Services (KIFS)	0.446 (0.151)	0.403 (0.183)		0.408 (0.179)	
Knowledge Intensive High-tech Services (KIHTS)	-0.548 (0.184)	-0.525 (0.205)		-0.523 (0.206)	
Knowledge Intensive Market Services (KIMS)	1.188 (0.00)***	1.050 (0.00)***		1.022 (0.00)***	
Other Knowledge Intensive Services (OKIS)	-0.152 (0.569)	-0.218 (0.428)		-0.210 (0.450)	
Knowledge Intensive Services (KIS)			0.094 (0.598)		0.102 (0.575)
Related Knowledge Entropy (KRE)	0.196 (0.031)**	0.175 (0.057)*	0.078 (0.318)	0.173 (0.061)*	0.077 (0.327)
Unrelated Knowledge Entropy (KUE)	0.186 (0.010)**	0.163 (0.022)**	0.222 (0.00)***	0.156 (0.013)**	0.214 (0.00)***
Broad Industrial Diversity Index (HHI)	0.100 (0.932)	0.201 (0.861)	0.219 (0.864)		
Employment Density (EMPDENS)	0.00002 (0.00)***	0.00002 (0.00)***	0.00002 (0.00)***	0.00002 (0.00)***	0.00002 (0.00)***
Public Sector Employment (PSEMP)	-0.372 (0.259)	-0.290 (0.359)	-0.466 (0.152)	-0.273 (0.386)	-0.448 (0.167)
Claimant Rate (CLAIMRATE)	-0.068 (0.00)***	-0.065 (0.00)***	-0.066 (0.00)***	-0.066 (0.00)***	-0.066 (0.00)***
Median Incomes (INCOME)	0.0009 (0.00)***	0.0009 (0.00)***	0.001 (0.00)***	0.0009 (0.00)***	0.001 (0.00)***
Old Industrial Region Dummy (OIR)	-0.018 (0.445)	-0.020 (0.392)	-0.032 (0.197)	-0.021 (0.378)	-0.033 (0.179)
City of London Dummy (LONDUM)	-0.377 (0.486)	-0.342 (0.549)	-0.582 (0.280)	-0.337 (0.549)	-0.584 (0.267)
W_LAG LNFB100	0.344 (0.00)***	0.341 (0.00)***	0.324 (0.00)***	0.341 (0.00)***	0.323 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using HAC standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.840	0.842	0.834	0.842	0.834

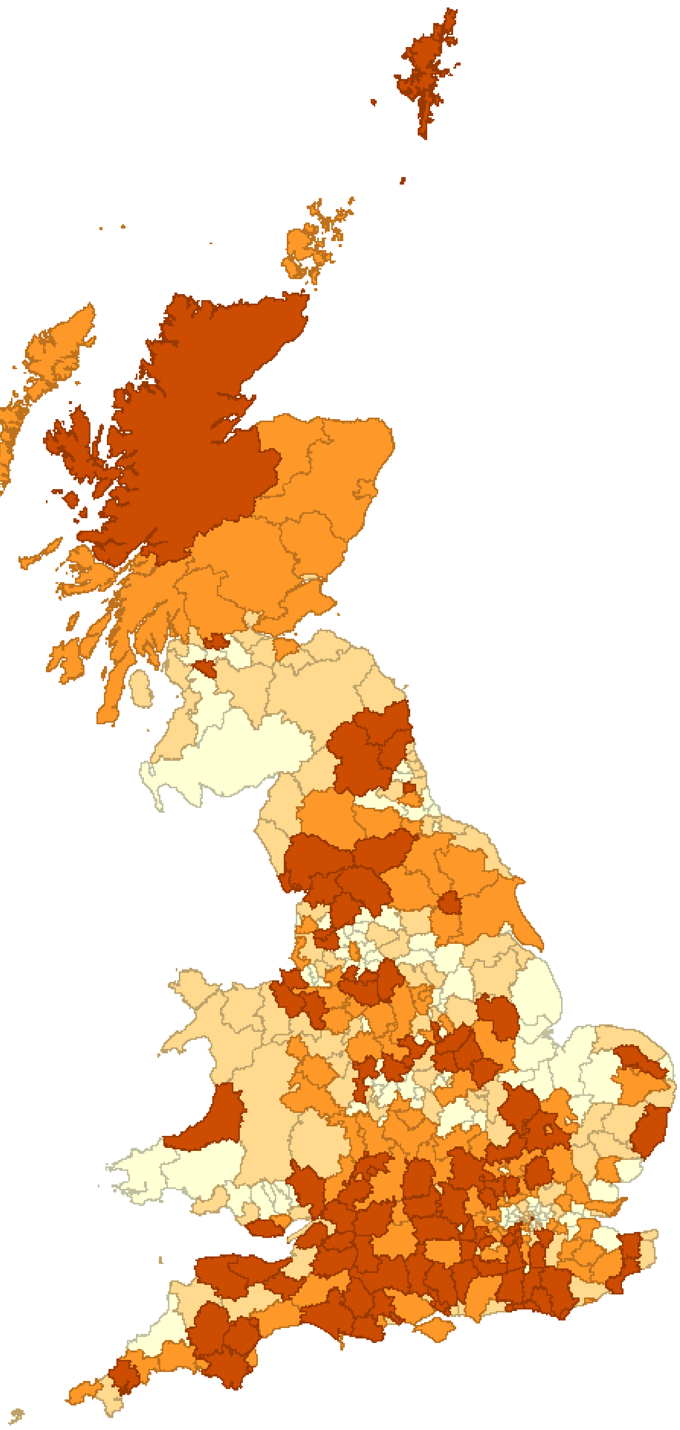
A16. Moran Scatterplot of LN(EMPDENS) using QCO1 spatial weights. The EMPDENS variable was logged due to the extremity of the City of London.



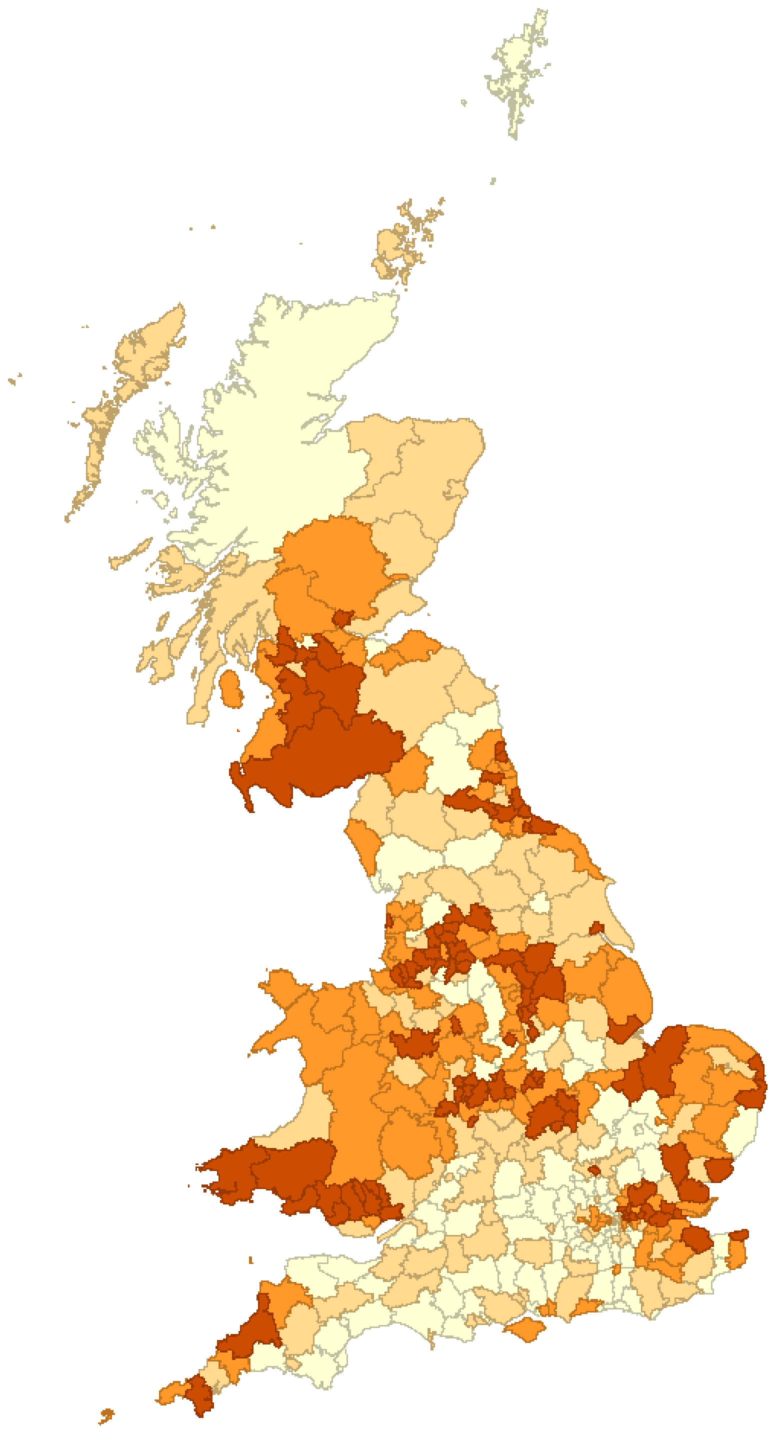
A17. Quartile map showing the spatial distribution of people holding a university degree (DEGREE). Darker regions show regional populations where a higher proportion of people hold a university degree, whereas the lighter regions signify regions where a lower proportion of people hold a degree.



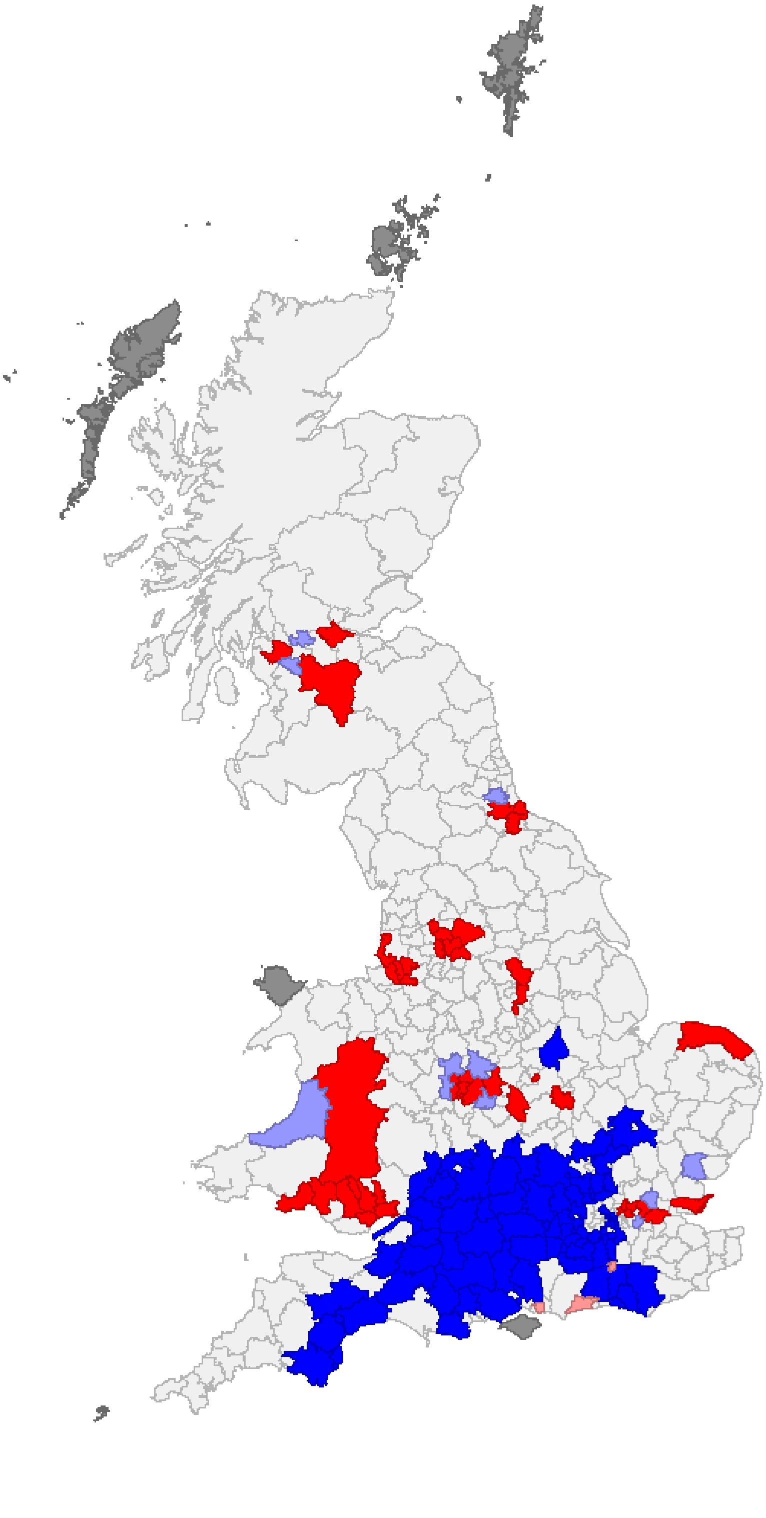
A18. Quartile map showing the spatial distribution of people with at least basic level of education (NVQ1PLUS). Darker regions show regional populations where a higher proportion of people who hold an educational qualification equivalent to an NVQ Level 1 and above, whereas the lighter regions signify regional populations lacking in in such qualifications.



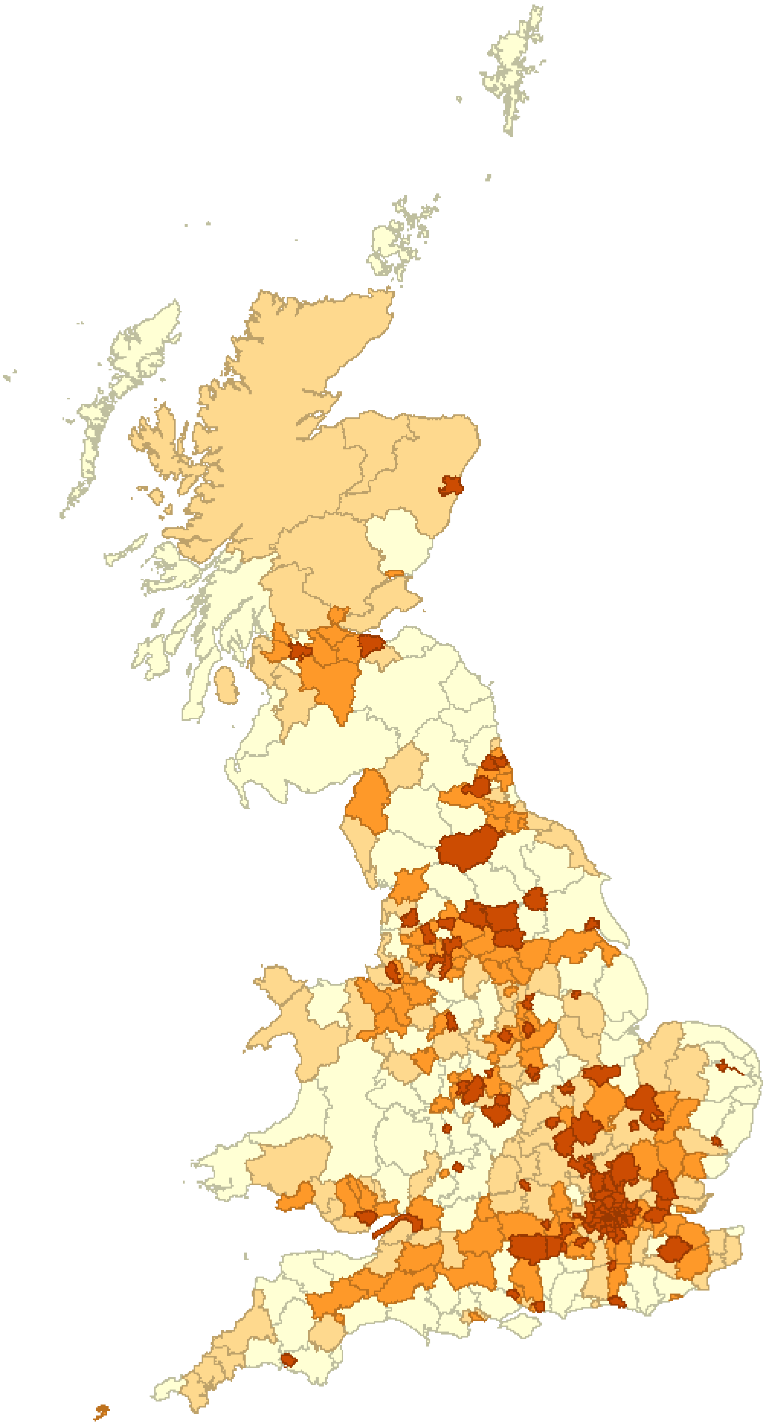
A19. Quartile map showing the spatial distribution of people lacking any formal education qualification (NOQUAL). Darker regions show regional populations where a higher proportion of people who lack any educational qualifications, whereas the lighter regions signify regional populations who have at least some form of formal education qualification.



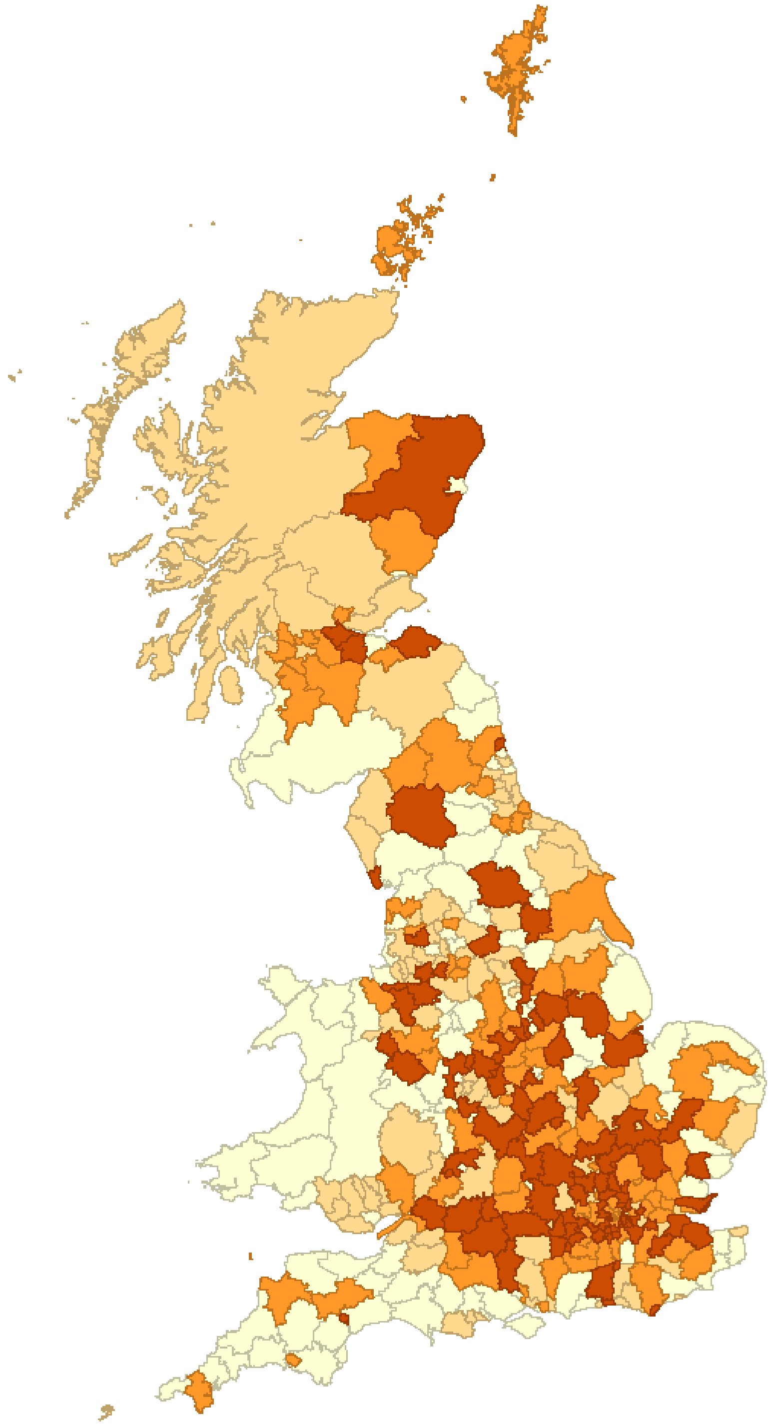
A20. LISA cluster map of the NOQUAL variable. The red areas show regions that exhibit a high concentration of people without any formal qualification, whereas the blue areas signify the opposite. Dark grey areas signify ‘neighbourless’ regions



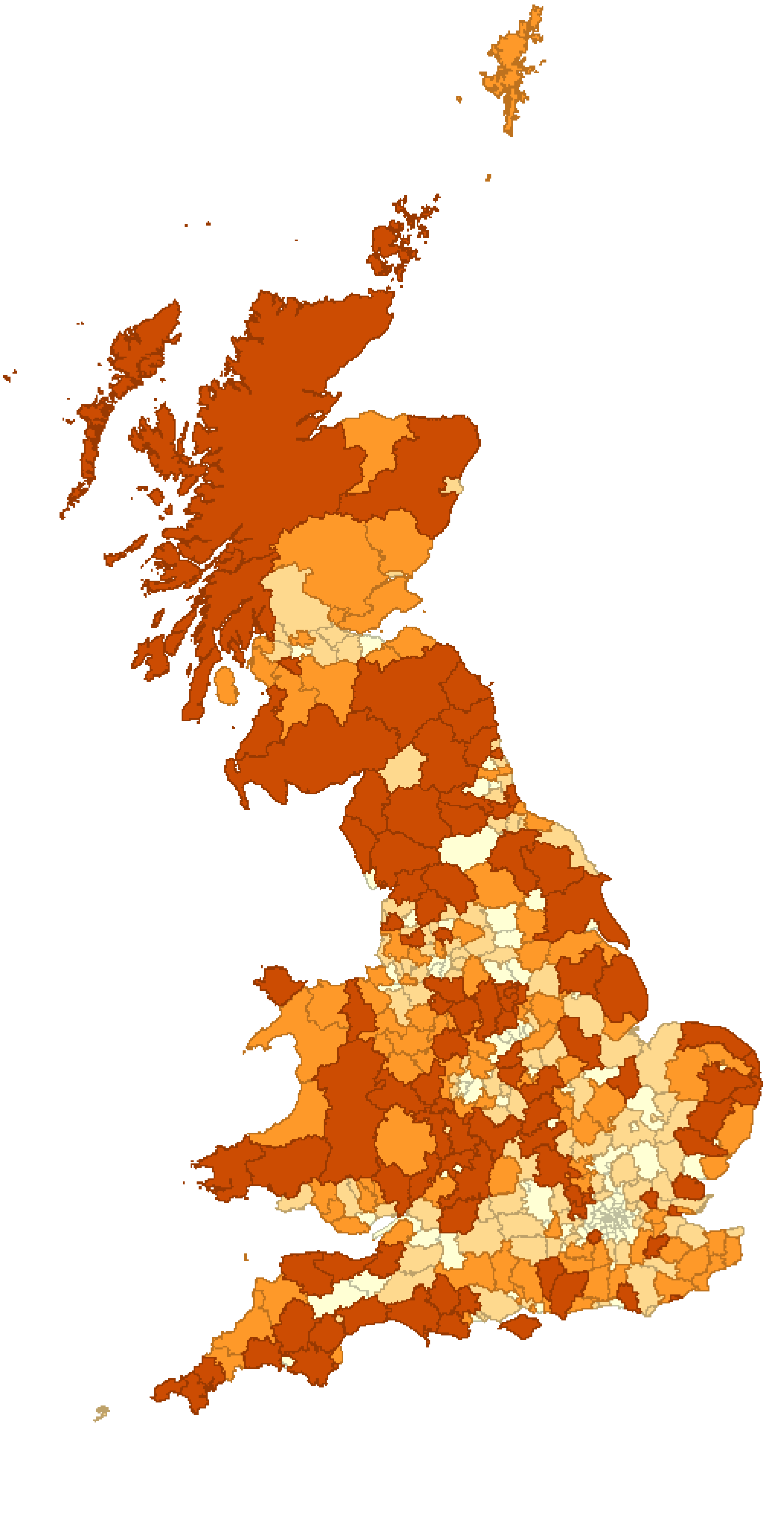
A21. Quartile mapping showing the spatial distribution of the PERC2534 variable. Darker shaded areas signify regions higher concentrations of people aged 25 to 34, whereas the lighter shaded regions signify lower concentrations of people aged 25 to 34.



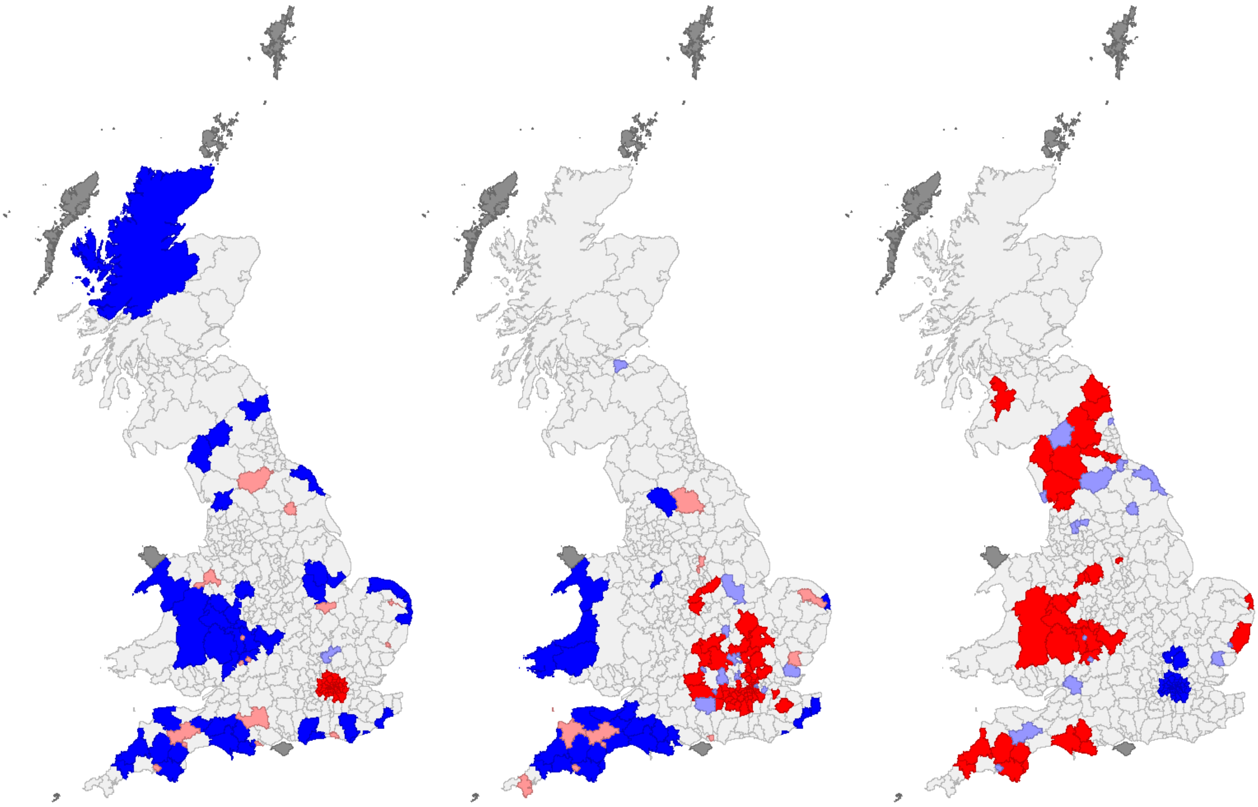
A22. Quartile mapping showing the spatial distribution of the PERC3549 variable. Darker shaded areas signify regions higher concentrations of people aged 35 to 49, whereas the lighter shaded regions signify lower concentrations of people aged 35 to 49.



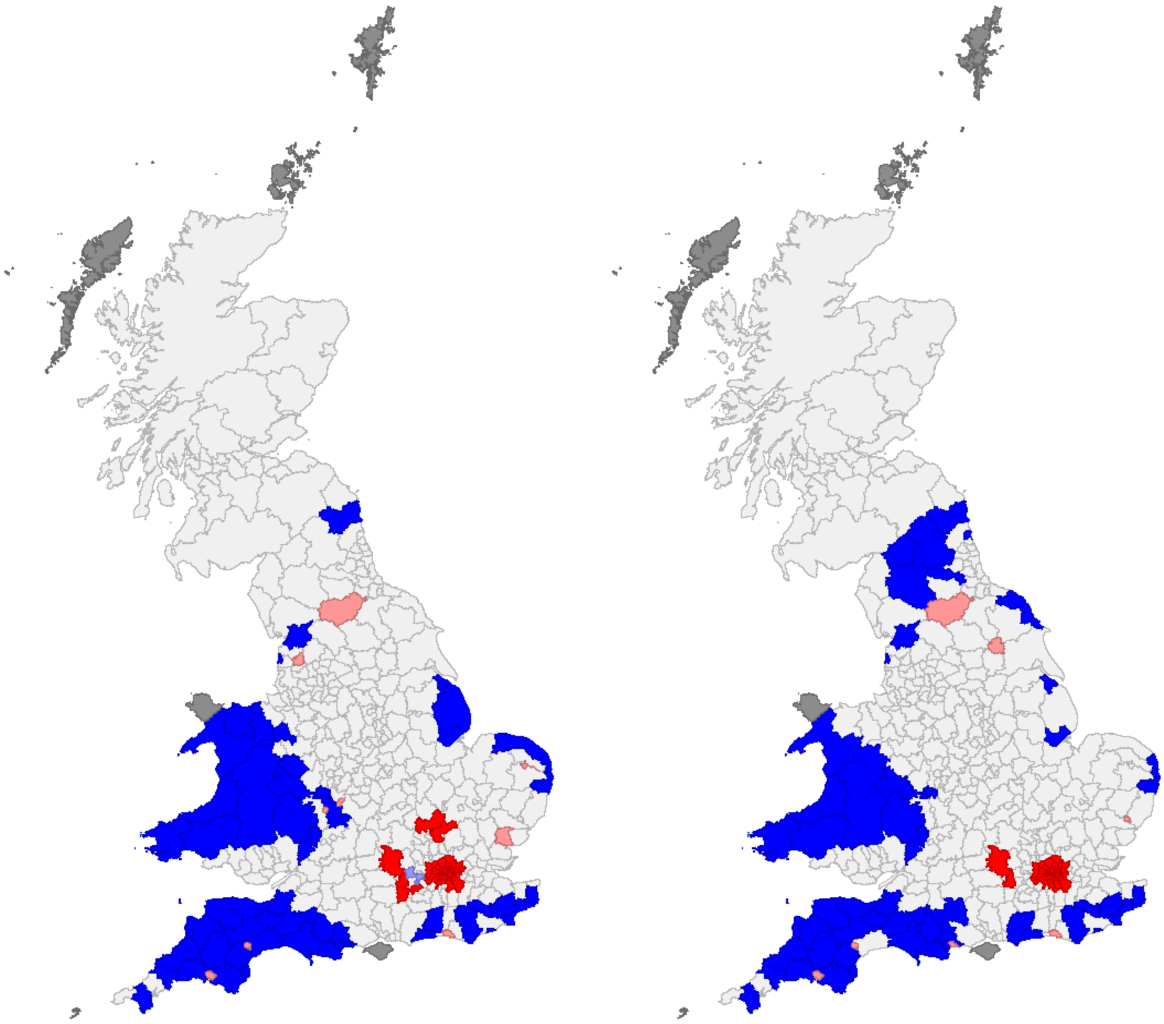
A23. Quartile mapping showing the spatial distribution of the PERC5064 variable. Darker shaded areas signify regions higher concentrations of people aged 50 to 64, whereas the lighter shaded regions signify lower concentrations of people aged 50 to 64.



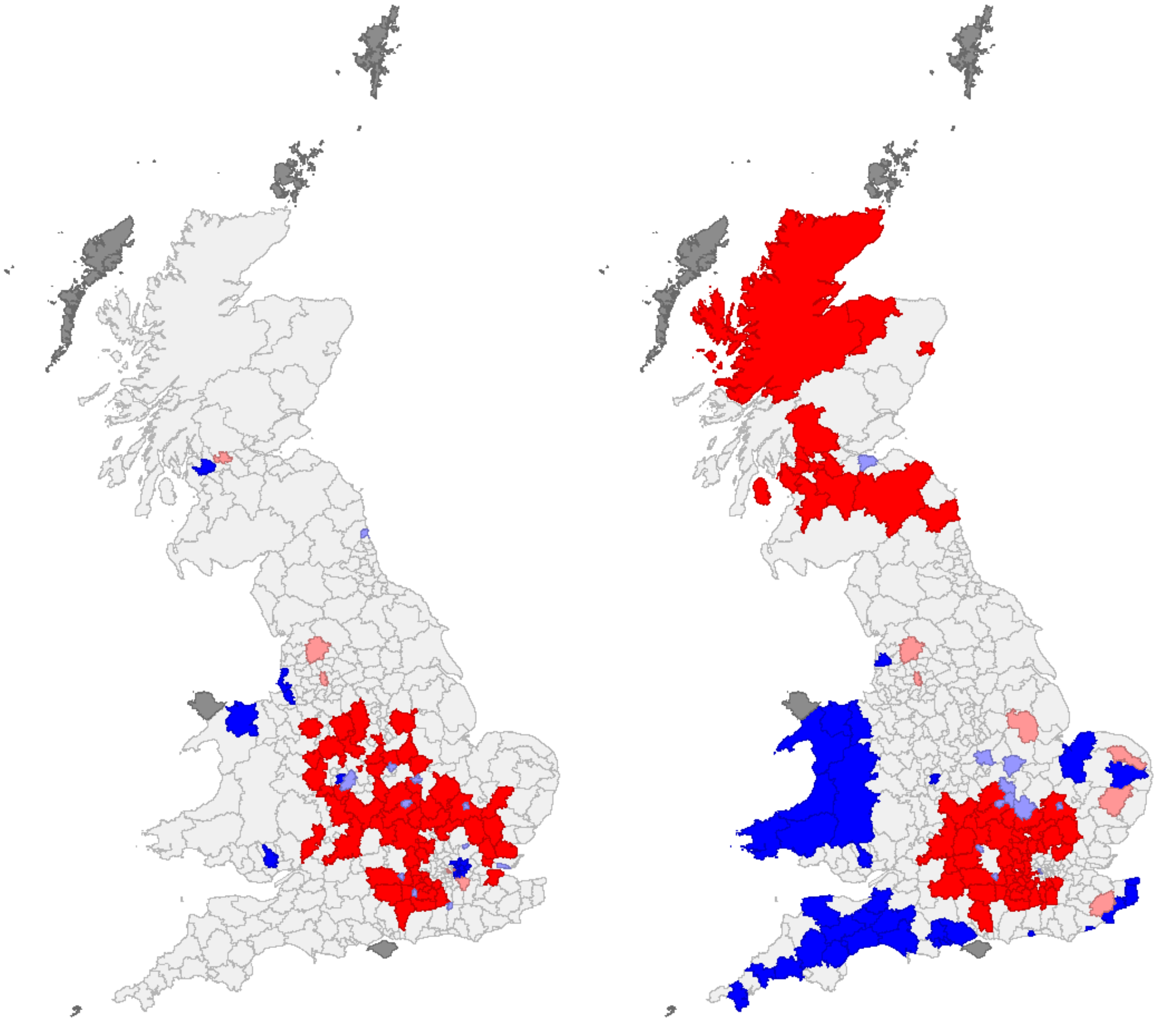
A24. LISA cluster maps of the PERC2534, PERC3549, and PERC5064 variables (left to right). The red shaded areas indicate clusters of positive spatial autocorrelation including regions with a high concentration of the particular age group, whereas the blue regions indicate clusters of positive spatial autocorrelation including regions with a low concentration of the particular age group.



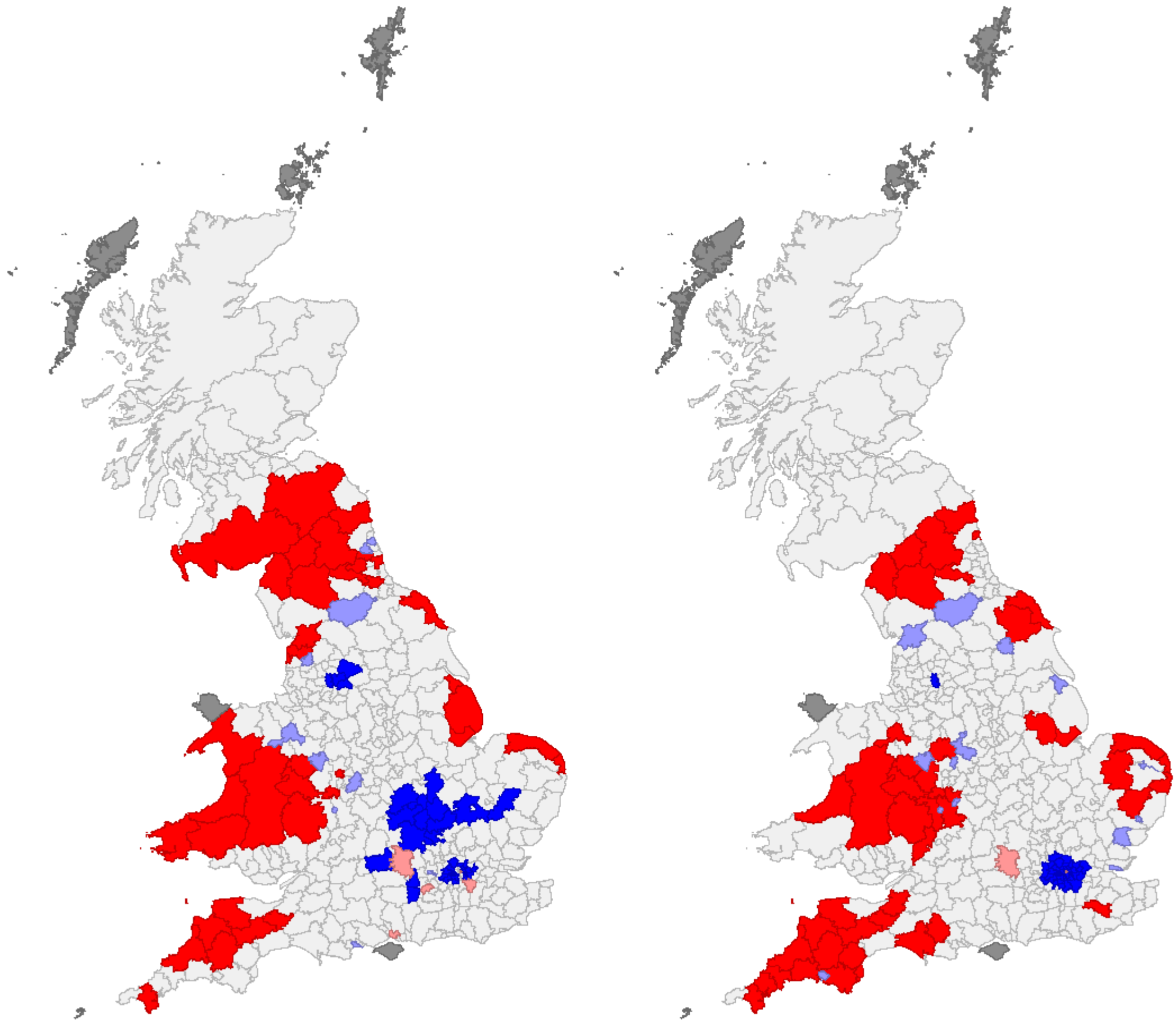
A25. LISA cluster maps of the PERC2534 variable in using 1991 (left) and 2001 (right) data. The red shaded areas indicate clusters of positive spatial autocorrelation including regions with a high concentration of people aged 25-34, whereas the blue regions indicate clusters of positive spatial autocorrelation including regions with a low concentration of people aged 25-34.



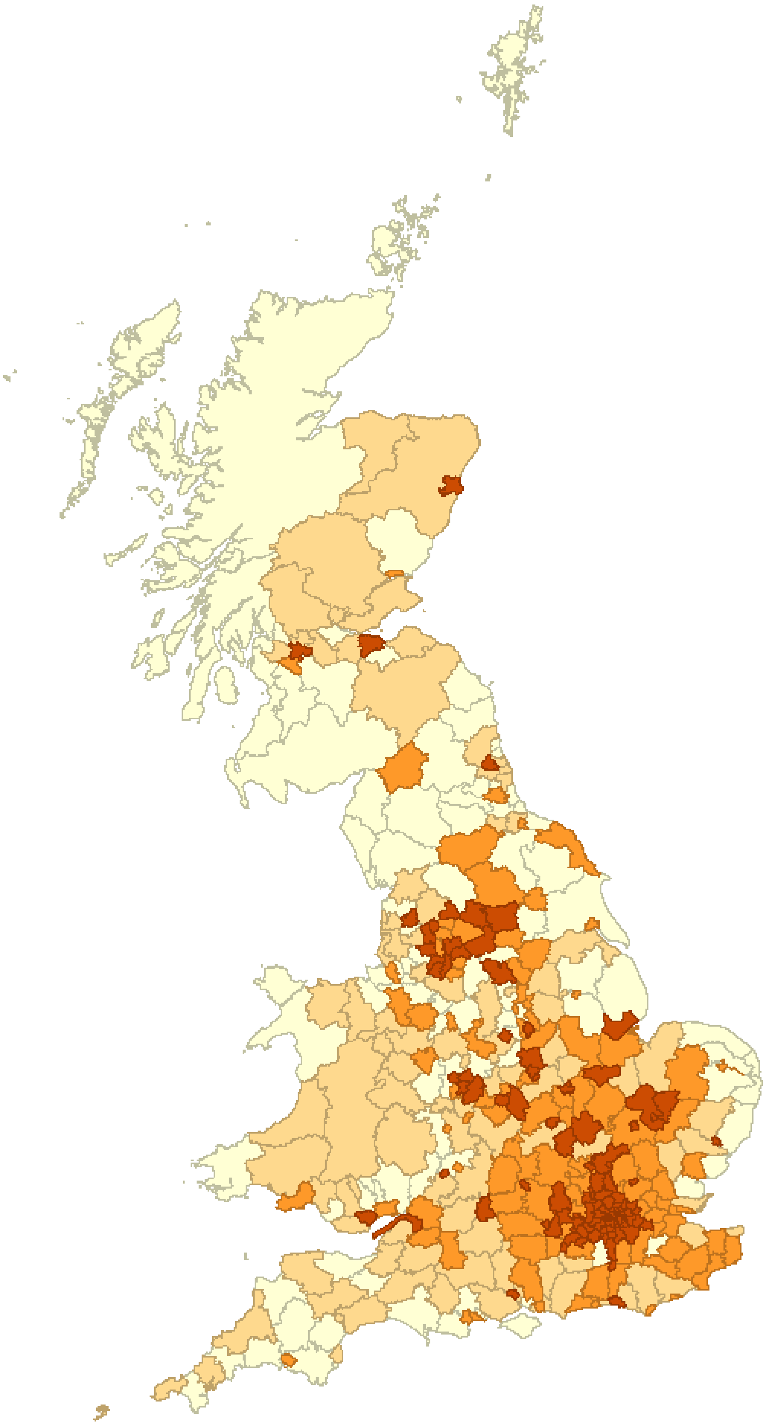
A26. LISA cluster maps of the PERC3549 variable in using 1991 (left) and 2001 (right) data. The red shaded areas indicate clusters of positive spatial autocorrelation including regions with a high concentration of people aged 35-49, whereas the blue regions indicate clusters of positive spatial autocorrelation including regions with a low concentration of people aged 35-49.



A27. LISA cluster maps of the PERC5064 variable in using 1991 (left) and 2001 (right) data. The red shaded areas indicate clusters of positive spatial autocorrelation including regions with a high concentration of people aged 50-64, whereas the blue regions indicate clusters of positive spatial autocorrelation including regions with a low concentration of people aged 50-64.



A28. Quartile map of the ETHDIV variable. Darker shaded areas show regions with a greater degree of ethnic diversity, whereas the lighter shaded areas show regions with a more ethnically homogeneous population.



A29. Data sources for all of the explanatory variables used in the regression analysis of Chapter 8

Variable	Source
DEGREE	Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Population Survey
NVQ1PLUS	Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Population Survey
NOQUAL	Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Population Survey
PERC2534	Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Population Survey
PERC3549	Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Population Survey
PERC5064	Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Population Survey
ETHDIV	Indices constructed using Labour market statistics compiled by the Office of National Statistics (NOMIS) Annual Population Survey

A30. Lagrange Multiplier spatial diagnostic tests for OLS models M1-M5 in Chapter 8 using QCO1, QCO2, 4NN, and 8NN spatial weights

Spatial Weights	LM Test	M1	M2	M3	M4	M5
QCO1	LM Lag	46.09 (0.00)	44.49 (0.00)	45.02 (0.00)	47.90 (0.00)	64.36 (0.00)
	Robust LM Lag	19.93 (0.00001)	20.53 (0.00001)	20.82 (0.00001)	20.86 (0.00)	24.86 (0.00)
	LM Error	43.45 (0.00)	37.42 (0.00)	37.67 (0.00)	44.731 (0.00)	66.49 (0.00)
	Robust LM Error	17.29 (0.00003)	13.46 (0.00024)	13.48 (0.00024)	17.684 (0.00003)	26.99 (0.00)
QCO2	LM Lag	26.74 (0.00)	24.36 (0.00)	24.51 (0.00)	27.72 (0.00)	49.23 (0.00)
	Robust LM Lag	13.29 (0.00027)	12.92 (0.00032)	13.12 (0.00029)	14.08 (0.00018)	27.58 (0.00)
	LM Error	31.40 (0.00)	24.59 (0.00)	24.21 (0.00)	31.12 (0.00)	41.83 (0.00)
	Robust LM Error	17.95 (0.00002)	13.15 (0.00029)	12.82 (0.00034)	17.48 (0.00003)	20.17 (0.00001)
4NN	LM Lag	63.00 (0.00)	59.77 (0.00)	60.16 (0.00)	65.40 (0.00)	83.73 (0.00)
	Robust LM Lag	16.32 (0.00005)	16.59 (0.00005)	16.72 (0.00004)	17.37 (0.00003)	21.57 (0.00)
	LM Error	57.30 (0.00)	51.50 (0.00)	51.76 (0.00)	58.48 (0.00)	73.63 (0.00)
	Robust LM Error	10.61 (0.00112)	8.32 (0.00391)	8.32 (0.00393)	10.45 (0.00123)	11.47 (0.00071)
8NN	LM Lag	65.60 (0.00)	63.24 (0.00)	64.12 (0.00)	68.68 (0.00)	95.93 (0.00)
	Robust LM Lag	14.68 (0.00013)	16.28 (0.00005)	16.56 (0.00005)	15.40 (0.00009)	23.21 (0.00)
	LM Error	83.75 (0.00)	72.70 (0.00)	73.32 (0.00)	87.15 (0.00)	109.40 (0.00)
	Robust LM Error	32.83 (0.00)	25.74 (0.00)	25.77 (0.00)	33.87 (0.00)	36.68 (0.00)

A31. Two stage least squares estimation (2SLS) of spatial models SM1-SM10 using QCO1 and QCO2 spatial weights with HAC/KP HET heteroskedasticity consistent standard errors. Dependent variable: LNFB1000. No. of observations = 408.

	SM1	SM2	SM3	SM4	SM5
Constant	0.753 (0.00)***	0.683 (0.011)**	0.717 (0.00)***	0.715 (0.00)***	0.804 (0.00)***
% of regional population who hold a degree (DEGREE)	0.0048 (0.013)**			0.0061 (0.003)***	0.011 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0005 (0.833)			
% of regional population who have no educational qualifications (NOQUAL)			0.0018 (0.565)	0.0063 (0.061)*	0.007 (0.062)*
% of regional population 16+ aged 25-34 (PERC2534)	-0.0097 (0.008)***	-0.0071 (0.063)*	-0.0071 (0.060)*	-0.0104 (0.004)***	-0.0091 (0.015)**
% of regional population 16+ aged 35-49 (PERC3549)	0.0023 (0.471)	0.0017 (0.602)	0.0016 (0.613)	0.0024 (0.455)	0.0110 (0.00)***
% of regional population 16+ aged 50-64 (PERC5064)	0.0073 (0.060)*	0.0074 (0.057)*	0.0070 (0.073)*	0.0064 (0.102)	0.0108 (0.008)***
Ethnic Diversity Index (ETHDIV)	0.111 (0.00)***	0.119 (0.00)***	0.116 (0.00)***	0.106 (0.00)***	0.114 (0.00)***
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-1.026 (0.004)***	-0.936 (0.005)***	-0.921 (0.005)***	-0.999 (0.004)***	-1.158 (0.014)**
Claimant Rate (CLAIMRATE)	-0.065 (0.00)***	-0.077 (0.00)***	-0.082 (0.00)***	-0.076 (0.00)***	-0.087 (0.00)***
Median Incomes (INCOME)	0.0012 (0.00)***	0.0014 (0.00)***	0.0015 (0.00)***	0.0012 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.094 (0.00)***	-0.089 (0.00)***	-0.091 (0.00)***	-0.100 (0.00)***	-0.107 (0.00)***
City of London Dummy (LONDUM)	-0.640 (0.118)	-0.747 (0.041)**	-0.772 (0.032)**	-0.652 (0.105)	-1.301 (0.001)***
W_LAG LNFB1000	0.169 (0.00)***	0.172 (0.00)***	0.172 (0.00)***	0.172 (0.00)***	0.206 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using HAC standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.823	0.819	0.819	0.825	0.804

	SM6	SM7	SM8	SM9	SM10
Constant	0.995 (0.00)***	0.841 (0.00)***	0.970 (0.00)***	0.958 (0.00)***	1.236 (0.102)
% of regional population who hold a degree (DEGREE)	0.0060 (0.006)***			0.0069 (0.003)***	0.013 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0015 (0.549)			
% of regional population who have no educational qualifications (NOQUAL)			-0.00003 (0.993)	0.0048 (0.180)	0.0043 (0.251)
% of regional population 16+ aged 25-34 (PERC2534)	-0.0082 (0.014)**	-0.0050 (0.163)	-0.0050 (0.155)	-0.0086 (0.009)***	-0.0086 (0.017)**
% of regional population 16+ aged 35-49 (PERC3549)	0.0011 (0.732)	0.0002 (0.948)	0.0002 (0.954)	0.0012 (0.687)	0.0085 (0.012)**
% of regional population 16+ aged 50-64 (PERC5064)	0.0066 (0.075)*	0.0063 (0.090)*	0.0061 (0.105)	0.0061 (0.103)	0.010 (0.013)**
Ethnic Diversity Index (ETHDIV)	0.111 (0.00)***	0.123 (0.00)***	0.119 (0.00)***	0.108 (0.00)***	0.110 (0.00)***
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00004 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***
Public Sector Employment (PSEMP)	-1.247 (0.00)***	-1.197 (0.00)***	-1.187 (0.00)***	-1.239 (0.00)***	-1.431 (0.003)***
Claimant Rate (CLAIMRATE)	-0.068 (0.00)***	-0.082 (0.00)***	-0.085 (0.00)***	-0.076 (0.00)***	-0.085 (0.00)***
Median Incomes (INCOME)	0.0013 (0.00)***	0.0016 (0.00)***	0.0017 (0.00)***	0.0013 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.085 (0.00)***	-0.085 (0.00)***	-0.086 (0.00)***	-0.089 (0.00)***	-0.091 (0.00)***
City of London Dummy (LONDUM)	-0.084 (0.010)***	-1.133 (0.004)***	-1.139 (0.005)***	-1.108 (0.009)***	-2.041 (0.00)***
Lambda (λ)	0.599 (0.00)***	0.542 (0.00)***	0.540 (0.00)***	0.600 (0.00)***	0.686 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using KP HET standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.798	0.795	0.795	0.799	0.761

A32. Two stage least squares estimation of spatial models SM11-SM20 using 4NN and 8NN spatial weights with HAC/KP HET heteroskedasticity consistent standard errors. Dependent variable: LNFB1000. No. of observations = 408

	SM11	SM12	SM13	SM14	SM15
Constant	0.621 (0.00)***	0.541 (0.037)**	0.594 (0.001)***	0.578 (0.002)***	0.632 (0.003)***
% of regional population who hold a degree (DEGREE)	0.0049 (0.00)***			0.0063 (0.003)***	0.011 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0007 (0.748)			
% of regional population who have no educational qualifications (NOQUAL)			0.0018 (0.556)	0.0064 (0.050)**	0.0068 (0.053)**
% of regional population 16+ aged 25-34 (PERC2534)	-0.0104 (0.003)***	-0.0076 (0.034)**	-0.0077 (0.031)**	-0.011 (0.002)***	-0.0101 (0.007)***
% of regional population 16+ aged 35-49 (PERC3549)	0.0016 (0.606)	0.0010 (0.750)	0.0009 (0.768)	0.0016 (0.594)	0.0096 (0.002)***
% of regional population 16+ aged 50-64 (PERC5064)	0.0061 (0.108)	0.0062 (0.105)	0.0058 (0.134)	0.0052 (0.180)	0.0091 (0.022)**
Ethnic Diversity Index (ETHDIV)	0.094 (0.00)***	0.104 (0.00)***	0.099 (0.00)***	0.088 (0.00)***	0.091 (0.00)***
Employment Density (EMPDENS)	0.00002 (0.002)***	0.00002 (0.00)***	0.00002 (0.00)***	0.00002 (0.004)***	0.00002 (0.008)***
Public Sector Employment (PSEMP)	-1.032 (0.012)**	-0.962 (0.015)**	-0.940 (0.016)**	-1.003 (0.012)**	-1.147 (0.026)**
Claimant Rate (CLAIMRATE)	-0.055 (0.00)***	-0.067 (0.00)***	-0.073 (0.00)***	-0.066 (0.00)***	-0.074 (0.00)***
Median Incomes (INCOME)	0.0011 (0.00)***	0.0014 (0.00)***	0.0014 (0.00)***	0.0011 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.063 (0.007)***	-0.059 (0.011)**	-0.061 (0.009)***	-0.068 (0.003)***	-0.068 (0.003)***
City of London Dummy (LONDUM)	0.688 (0.352)	0.526 (0.375)	0.510 (0.381)	0.704 (0.348)	0.397 (0.670)
W_LAG LNFB1000	0.288 (0.00)***	0.281 (0.00)***	0.283 (0.00)***	0.295 (0.00)***	0.353 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using HAC standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.830	0.825	0.826	0.832	0.815
Anselin-Kelejian Test	2.546 (0.111)	2.183 (0.140)	2.105 (0.147)	2.194 (0.139)	2.176 (0.140)

	SM16	SM17	SM18	SM19	SM20
Constant	0.959 (0.00)***	0.873 (0.00)***	0.910 (0.00)***	0.905 (0.00)**	1.241 (0.00)***
% of regional population who hold a degree (DEGREE)	0.0059 (0.008)***			0.0072 (0.002)***	0.012 (0.00)***
% of regional population who hold an NVQ Level 1 and above (NVQ1PLUS)		0.0006 (0.807)			
% of regional population who have no educational qualifications (NOQUAL)			0.0015 (0.643)	0.0065 (0.066)*	0.0060 (0.100)*
% of regional population 16+ aged 25-34 (PERC2534)	-0.0067 (0.045)**	-0.0034 (0.348)	-0.0033 (0.353)	-0.0072 (0.030)**	-0.0076 (0.031)**
% of regional population 16+ aged 35-49 (PERC3549)	0.0030 (0.306)	0.0022 (0.468)	0.0022 (0.467)	0.0033 (0.263)	0.0085 (0.007)***
% of regional population 16+ aged 50-64 (PERC5064)	0.0076 (0.037)**	0.0073 (0.044)**	0.0071 (0.052)*	0.0070 (0.053)*	0.010 (0.006)***
Ethnic Diversity Index (ETHDIV)	0.091 (0.00)***	0.102 (0.00)***	0.098 (0.00)***	0.086 (0.00)***	0.082 (0.002)***
Employment Density (EMPDENS)	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00003 (0.00)***	0.00004 (0.00)***
Public Sector Employment (PSEMP)	-0.944 (0.004)***	-0.905 (0.004)***	-0.896 (0.004)***	-0.934 (0.004)***	-1.063 (0.010)***
Claimant Rate (CLAIMRATE)	-0.064 (0.00)***	-0.080 (0.00)***	-0.084 (0.00)***	-0.075 (0.00)***	-0.086 (0.00)***
Median Incomes (INCOME)	0.0012 (0.00)***	0.0016 (0.00)***	0.0016 (0.00)***	0.0013 (0.00)***	
Old Industrial Region Dummy (OIR)	-0.098 (0.00)***	-0.095 (0.00)***	-0.097 (0.00)***	-0.104 (0.00)***	-0.111 (0.00)***
City of London Dummy (LONDUM)	-0.958 (0.103)	-0.931 (0.064)*	-0.930 (0.068)*	-0.958 (0.120)	-1.686 (0.005)***
Lambda (λ)	0.591 (0.00)***	0.567 (0.00)***	0.570 (0.00)***	0.601 (0.00)***	0.678 (0.00)***
P-values to coefficient t-statistics given in brackets, adjusted for heteroskedasticity using KP HET standard errors. *** denotes significance at 99% confidence level, ** significance at 95% confidence level, * significance at 90% confidence level.					
Pseudo-R^2	0.795	0.793	0.793	0.796	0.753